A Times Mirror Magazine

Popular Science

The Sound Of Global Warming

Digital Money

CRISIS IN SPACE

The Inside Story Of The Apollo 13 Moon Mission

JULY 1995
$2.50
CANADA $2.95

Copyrighted material

IT'S AS FINELY TUNED UNDER THE ROOF

In designing the Galant LS, we strived to create a car that excelled in every respect. It offers more interior room than Accord EX or Altima GLE.* And with an available Luxury Package, there's plush leather trim, an 8-speaker Mitsubishi/Infinity® audio system, plus meaningful luxuries like a power driver's seat you can adjust four ways, and a security system with remote keyless entry. There's also an exclusive feature called Mitsubishi HomeLink™, which lets you operate security gates, garage doors, even house lights, all as you pull up your driveway.† Powering the Galant is a confident 141-horsepower**engine, with a very smooth automatic transmission. Anti-lock brakes are available, and dual air bags are standard. And, the Galant S starts at $14,421, while the Galant LS with Luxury Package is $23,273.†† Probably why *Road & Track* said, "It's without question, a lot of car for the money."*** To which you'll surely add, "A lot of *finely tuned* car for the money." For the Mitsubishi Motors Dealer nearest you, call 1-800-55MITSU.

INTRODUCING THE LUXURIOUS

NEW GALANT LS.

G A L A N T

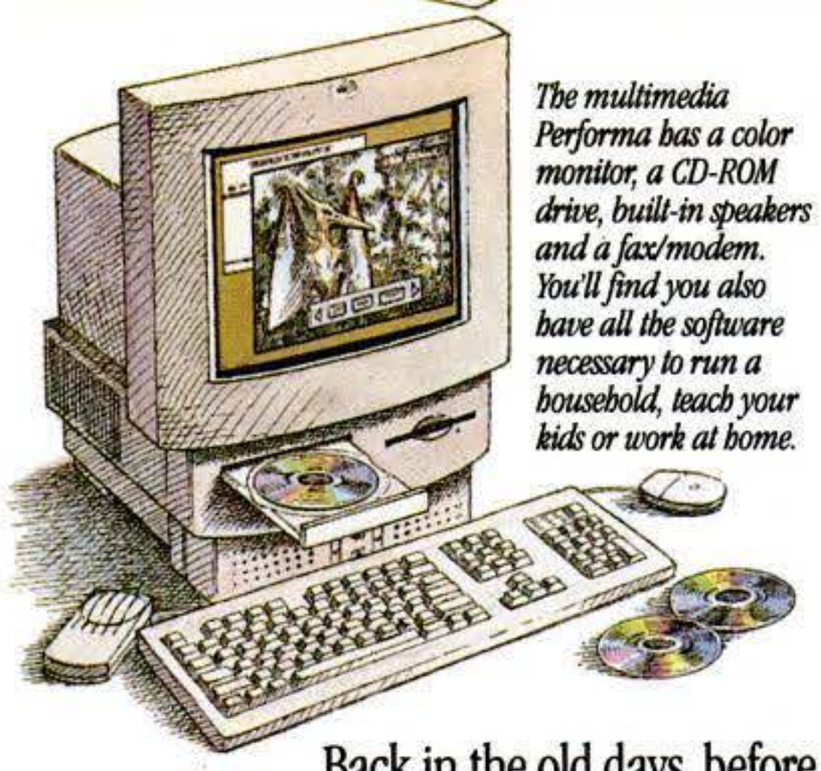
MITSUBISHI

The New Thinking in Automobiles™

Copyrighted material

*Comparison based on most current information. †Mitsubishi HomeLink™ System is exclusive to Galant in midsize sedan segment. House lights operable with HomeLink's™ optional Lighting System. **138 horsepower for CA Emissions Vehicles. ††Mitsubishi HomeLink™ available on LS model only. Prices exclude taxes, title, license, registration fee, freight, dealer options, and charges. ***Road & Track 1995 Car Buyer's Guide.

Copyrighted material



The multimedia Performa has a color monitor, a CD-ROM drive, built-in speakers and a fax/modem. You'll find you also have all the software necessary to run a household, teach your kids or work at home.

Back in the old days, before computers roamed the earth, people used to learn things by reading words on a page.

But then, that was before ideas came to life, squawking and swooping and flapping their way off computer screens and into your imagination.

Welcome to multimedia for Macintosh.®

What is multimedia, anyway?

Multimedia computing brings together different types of media: text, illustration, photos, sounds, animation, speech and video. And with an Apple® Macintosh Performa,® it's easy. Just pop a multimedia CD-ROM into the computer.

Take any number of dinosaur CDs. You can read all about pterodactyls, then hit a video button and zoom in for a closer look. Watch a paleontologist talk about the flying lizard. Or go listen to the *T. rex* roar again.

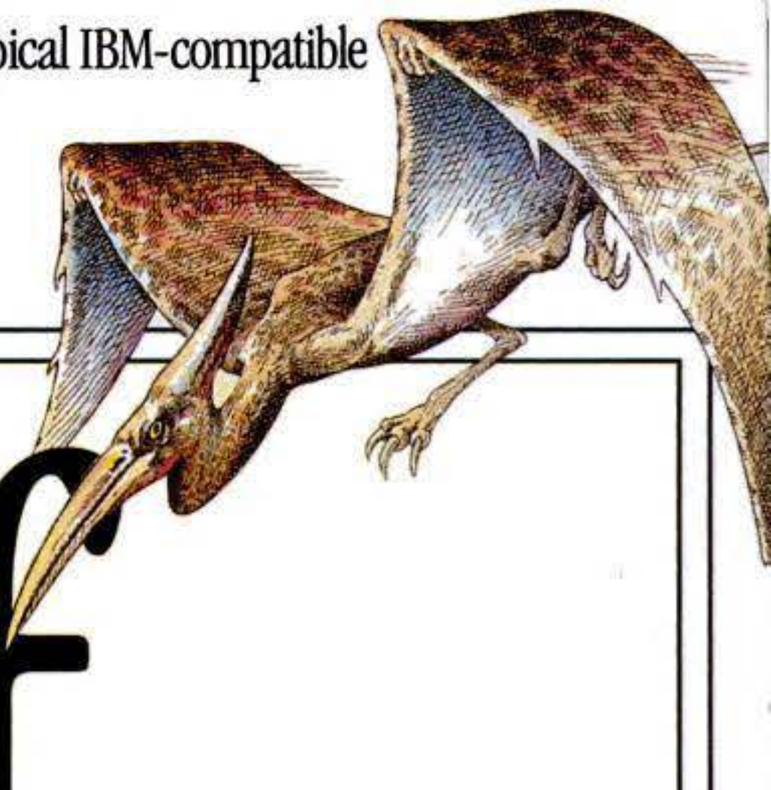
Instead of dry text, you get an eyeful. And an earful. And eventually, a mind full.

New ideas are continually reinforced, and interactive controls let you go at your own pace. So kids learn faster and retain more. (Maybe that's why more schools use Apple computers than any other kind.)

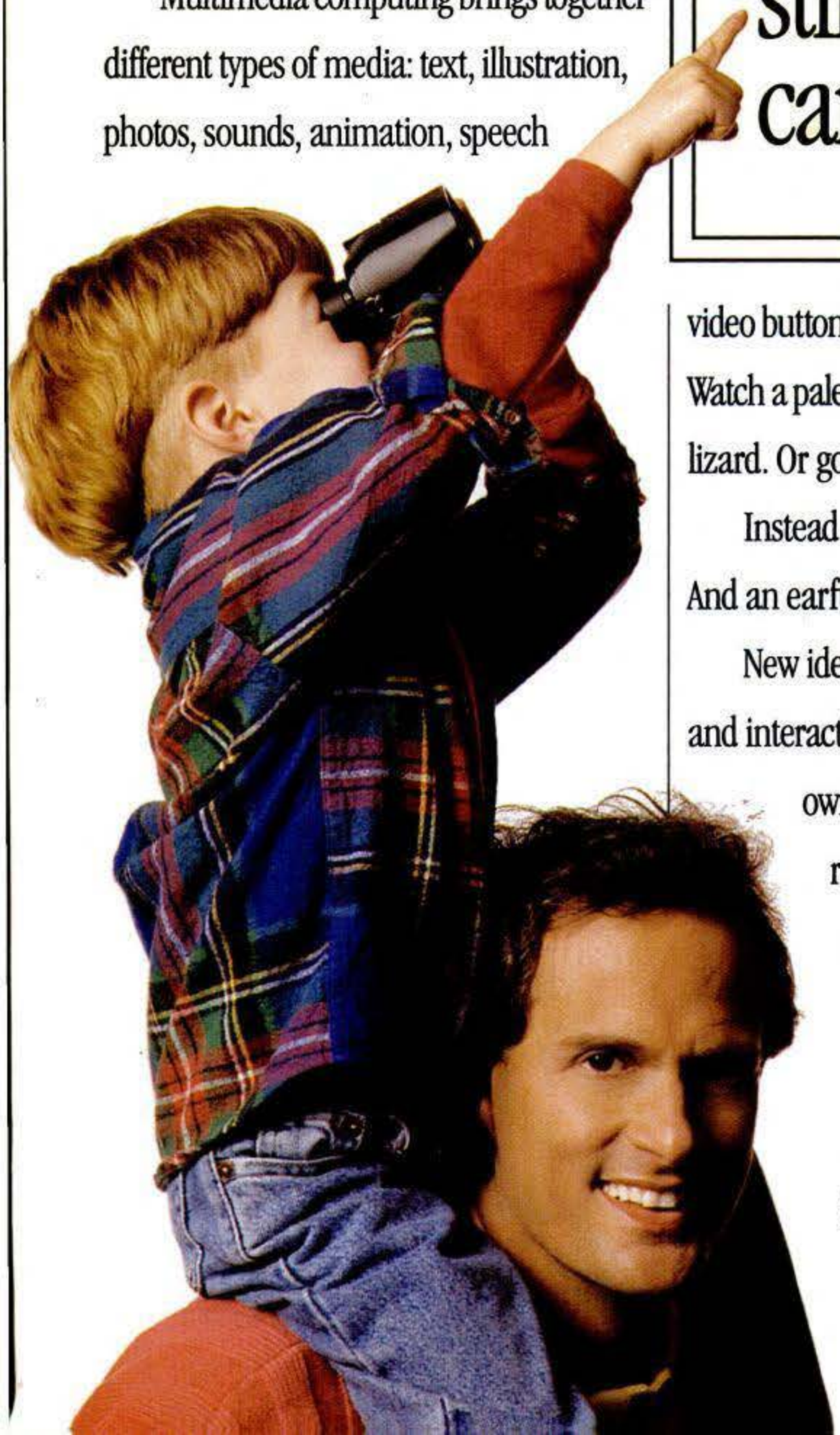
Why is Macintosh better?

As Walter Mossberg noted in *The Wall Street Journal* on January 13, 1994, "Getting multimedia hardware and, especially, software to run on a typical IBM-compatible computer can be a frustrating—even impossible—task....In general, users of Apple's Macintosh computers face very few of these problems, because a single company—Apple...has made sound, graphics and video a priority."*

In other words, Performa makes multimedia easy—as easy as using a Mac.® So capture one, and discover a world of sight, sound and power. The power to be your best.®



If a computer stimulates your eyes and ears, can your mind be far behind?



Performa®

The Family Macintosh

*To locate your nearest Apple retailer, give us a call at 800-538-9696, ext. 215. © 1994 Apple Computer, Inc. All rights reserved. Apple, the Apple logo, Mac, Macintosh, Performa and "The power to be your best" are registered trademarks of Apple Computer, Inc. *Excerpt from the January 13th, 1994, "Personal Technology" column by Walter S. Mossberg titled "Behind the Hype Lurks the Darker Side Of Multimedia" reprinted by permission of* The Wall Street Journal *and Dow Jones & Company, Inc.*

Copyrighted material

Popular Science

THE WHAT'S NEW MAGAZINE

JULY 1995

A TIMES-MIRROR MAGAZINE

FOUNDED IN 1872

VOLUME 247

NUMBER 1

COVER BY TOM WHITE

DEPARTMENTS

Editor's Note 4

Readers Talk Back 6

What's New 10

Newsfronts
Science & Technology 21
Automotive 27
Home Technology 35
Electronics 40
Computers & Software 44

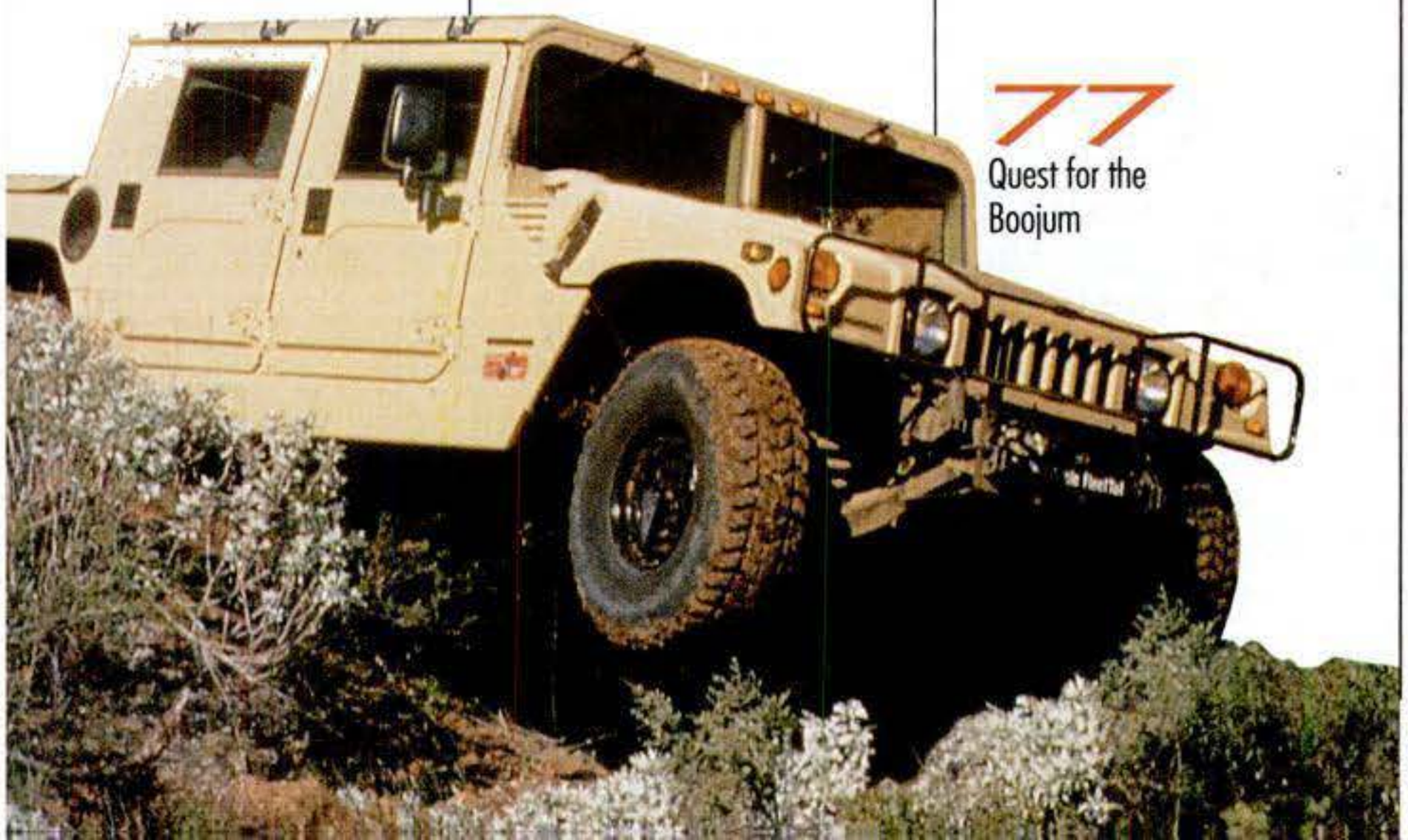
Looking Back 100

50
Crisis in Space

74
E-Money

66
The Forecast for Wind Power

59
The Sound of Global Warming



77
Quest for the Boojum

FEATURES

Crisis In Space: The Heroic Voyage Of Apollo 13
50
A jaded nation yawned at Apollo 13's liftoff. But when a massive explosion disabled the mission, the life-and-death struggle in space transfixed the world. The indomitable courage of the crew and their counterparts at Mission Control proved NASA still had the right stuff.

The Sound Of Global Warming
59
Cold War spy technology could provide the world's largest ocean thermometer. But the program, which uses sound waves to improve global climate predictions, may be scrapped if whales and sea lions object.

The Ocean Express
64
Waterjet-propelled cargo ships promise to slash ocean-crossing times in half by 1998. For consumers, the new jet age of cargo shipping could spell timelier delivery, wider choice, and lower prices.

The Forecast For Wind Power
66
Affordable electricity from the wind? Advanced turbine technology is making it a breeze. Wind power plants that will go online this year will sell electricity at prices that are competitive with fossil fuels and nuclear energy.

E-Money
74
If you thought e-mail changed your life, wait until you get a fistful of this new kind of cash. Smart cards will soon be intelligent enough to replace dollars and cents.

Quest For The Boojum
77
Hummers—civilian versions of the military-utility vehicle used in the Persian Gulf War—are the ultimate dirt trucks. What better vehicle for trekking through the cactus gardens of Baja California in search of the towering Boojum tree?

Copyrighted material

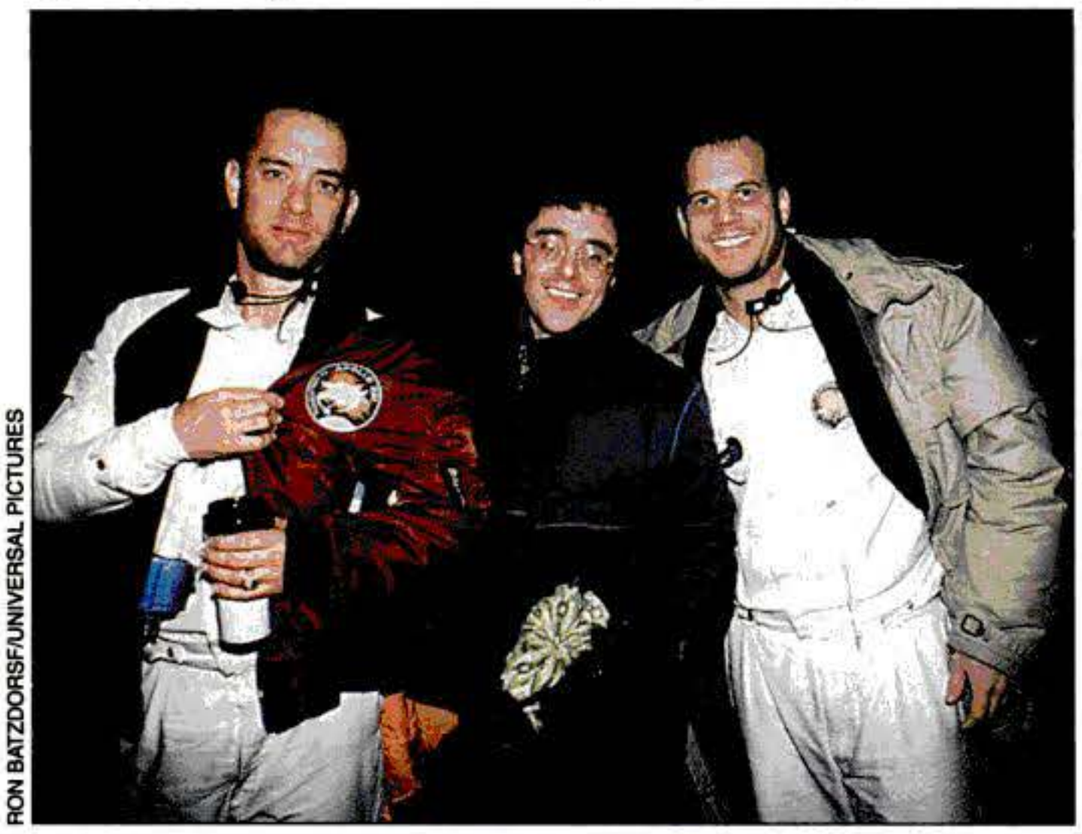
EDITOR'S NOTE

NASA's Finest Hour

By most standards, the Apollo 13 moon mission was a failure; the astronauts never did achieve the world's third lunar landing. But a much different perspective will arrive on June 30 with the release of the Universal Pictures movie *Apollo 13*. Director Ron Howard and a cast headed by Tom Hanks will recreate the life-and-death saga of this perilous mission, which many now regard, 25 years later, as NASA's finest hour.

In this month's cover story, Apollo expert Andrew Chaikin retells this stunning tale of a spaceship crippled by an explosion—and the heroic efforts of the astronauts and ground crews to bring it back to Earth safely. There is no better authority on the Apollo program than Chaikin, whose acclaimed history, *A Man on the Moon: The Voyages of the Apollo Astronauts*, has just been published in paperback by Penguin. Chaikin's most recent appearance in these pages, "The Last Men on the Moon," was an account of the final moon mission, Apollo 17.

Another excellent source of space mission history is the U.S. Space Foundation in Colorado Springs, Colo. POPULAR SCIENCE editors and artists worked with the Space Foundation, the Houston Space Center, the National Space Society, and Universal Pictures to produce a lavishly illustrated study-guide poster based on the Apollo 13 mission. For more information about this poster, teachers can call 800-691-4000.



RON BATZDORSF/UNIVERSAL PICTURES

***Apollo 13* stars (left to right) Tom Hanks, Andy Chaikin, and Bill Paxton**

Does it seem as though everything has gone digital? That's not just perception—it's reality. Take contributor Phil Patton's dispatch from the cyberfront on digital money. Today, in more ways than you might think, the convenience of electronic money is displacing the limitations of conventional cash. Familiar coins and bills may soon give way to a new generation of smart cards. With e-money, you pay as you go for all manner of everyday purchases, from newspapers and coffee in the morning, to transit fares and highway tolls during the day, to department store purchases and restaurant meals after work. A major test for e-money in the United States is coming up at the Olympic Games in Atlanta in 1996. Patton says of the smart cards: "They are to the credit card what the compact disc was to the LP record."

As we continue this year's special project coverage of our Ocean Planet, West Coast Senior Editor Stuart Brown brings us up to date on a controversial future experiment designed to help us learn more about global warming. Environmentalists and geophysicists have wound up uncharacteristically at odds with each other over the acoustic thermometry of ocean climate (ATOC) program, which plans to transmit low-frequency sound waves through vast areas of the Pacific Ocean.

Making concessions to some environmental groups and marine biologists critical of the program, ATOC officials now propose relocating an underwater sound-emitting device 48 miles off the California coast. Originally, the device was to be within the boundaries of the Monterey Bay National Marine Sanctuary.

The effect of strong low-frequency sound on marine mammals is poorly understood. So, before the ATOC program ramps up to full capacity, some $3 million will be spent to study the effects of such sounds on whales, seals, and sea lions—the largest sum ever spent on marine mammal research.

EDITOR-IN-CHIEF

Popular Science

Editor-in-Chief Fred Abatemarco
Editor Richard L. Stepler
Executive Editors Arthur Fisher, Cecilia Wessner
Art Director W. David Houser

Managing Editor Candace Golanski
Senior Editors Michael Antonoff, Stuart F. Brown, Mariette DiChristina, Dan McCosh, Dawn Stover
Associate Editor Robert Langreth
Copy Chief Bob Sillery
Staff Photographer John B. Carnett
Assistant Editor Suzanne Kantra Kirschner
Graphics Production Coordinator Kim O'Reilly
Editorial Assistant Wendi E. Black
Administrative Assistant Marcie Mason
Picture Editor Cynthia van Roden
European Correspondent David Scott
Far East Correspondent Dennis Normile
Contributing Editors Robert Gannon, Michael Morris, Chris O'Malley, Don Sherman, P. J. Skerrett, Bill Sweetman, Mark D. Uehling

Popular Science Properties
President Patricia G. Campbell
Vice President & General Manager Nancy C. Walker
Vice President & Editorial Director Fred Abatemarco
Vice President & Publisher Ron Bernstein
National Sales & Marketing Manager Michele Folman
Eastern Advertising Office: Sales Manager Michele Brown; **National Manager Platinum/Heartland Sales** Ed Baker; Claudia Ryan, Barry H. Weinberg, Valerie Ambrister, Brenda Charles (212) 779-5000; **Midwest Advertising Office: Manager** John Zeman; Hans Theisen, Dawn Zabel (312) 337-7896; **West Coast Advertising Office: Manager** Craig Lee (310) 315-4380; **Detroit Advertising Office: Manager** Keith D. Cunningham; **Direct Response Manager** Diane Pahl; Lynne Gushman (810) 350-3800
Marketing/Research Director Ross Ruriani
Promotion Manager Taryol Latimer
Business Manager Tony Buzzeo
Advertising Coordinator Ellie Norton
Consumer Marketing Director Dan Dynan
Director, Classified Operations Richard Goldberg
Manufacturing Operations Director Gerald Palacios
Production Director Laurel Kurnides
Production Manager Marie Guenver
Associate Quality Control Manager John Francesconi

Times Mirror Magazines

Chairman of the Board Ann E. Dilworth
President & Chief Executive Officer Francis P. Pandolfi
Executive Vice President & Group Publisher James L. Kopper
Executive Vice President, Brand Development Patricia G. Campbell
Senior Vice President, Finance & Administration Michael J. Haugh
Senior Vice President, Operations Scott W. Kabak
Senior Vice President; George Bell
Associate Group Publisher Deb Lees
Vice President, Accounting Nicholas A. DeCarlo
Vice President, Manufacturing Kit Taylor
Director, Corporate Sales Stephen R. Burzon
Corporate Marketing Director Ellen Pedersen
Vice President, Multimedia Jack Horstmeyer
Corporate Research Director Stephen R. Frost
Public Relations Director Linda W. Boff
Conservation Council Executive Director David B. Rockland, Ph.D.

Photocopy Permission Permission is granted by Popular Science® for libraries and others registered with the Copyright Clearance Center (CCC) to photocopy articles in this issue for the flat fee of $1 per copy of each article or any part of an article. Send correspondence and payment to CCC (21 Congress St., Salem, Mass 01970); specify CCC code 0161-7370/85/$1.00— 0.00. Copying done for other than personal or reference use without the written permission of Popular Science® is prohibited. Address requests for permission on bulk orders to Beth Barber, L.A. Times Syndicate, Intl., 2 Park Ave., New York NY 10016 for foreign requests. For domestic requests, write or call Reprint Management Services, Inc., 147 West Airport Rd., P.O. Box 5363, Lancaster, PA 17606-5363; 717-560-2001 (FOR ARTICLE REPRINTS ONLY). Popular Science® is a registered trademark of Times Mirror Magazines, Inc.

POPULAR SCIENCE **Business and Executive Offices:** 2 Park Ave., New York NY 10016. **Editorial Offices:** Address contributions to Popular Science, Editorial Dept., 2 Park Ave., New York NY 10016. We are not responsible for loss of unsolicited materials. They will not be returned unless accompanied by return postage. Microfilm editions are available from Xerox University Microfilms Serial Bid Coordinator, 300 N. Zeeb Rd., Ann Arbor MI 48106. **Subscription Inquiries:** Send new or renewal subscriptions or change of address (send both new and old addresses) to Popular Science, Box 5096, Harlan IA 51593-2596. Allow six to eight weeks for change of address. If you have a subscription problem, please write to the above address. **Subscriptions:** U.S. and its possessions, 1 year $13.94; 2 years $24.97; 3 years $34.97. For Canada, add $7 per year (includes GST). For Foreign, add $8 per year. Subscriptions processed electronically. **Postmaster:** Send change of address notices to Popular Science, Box 5096, Harlan IA 51593-2596. Popular Science entered as second-class postage paid at New York NY and additional mailing offices. Canada Post Canadian Publications Mail Product Agreement No. 56219. Canada GST Registration Number R-122988066. Popular Science (ISSN 0161-7370) is published monthly by Times Mirror Magazines, Inc., 2 Park Ave., New York NY 10016.

Printed in the U.S.A.

Copyrighted material

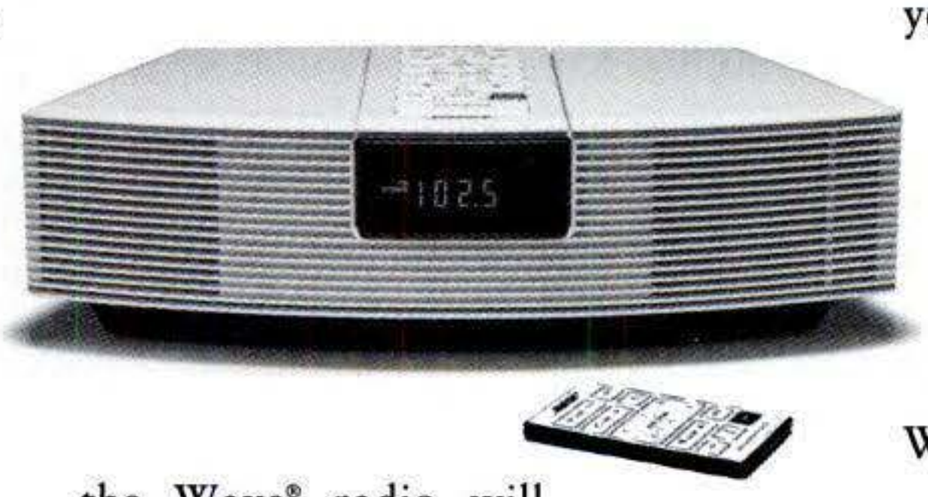
Why you should pay $349 for this radio.

Obviously, it better not be just another radio. This one isn't. Quite simply, the Bose® Wave® radio gives you sound that's richer, more natural, more lifelike than you've ever heard from a radio. Many people think it actually sounds more like a stereo system. It's no exaggeration to say you have to hear it to believe it.

Finally, Bose sound from a small radio.

The Wave® radio is from Bose, one of the world's leading makers of audio equipment. A few years ago, we undertook the task of getting Bose-quality sound from a small radio. To do it, we used our patented acoustic waveguide speaker technology. Just as a flute strengthens a breath of air to fill an entire concert hall, the waveguide produces room-filling sound from a small enclosure.

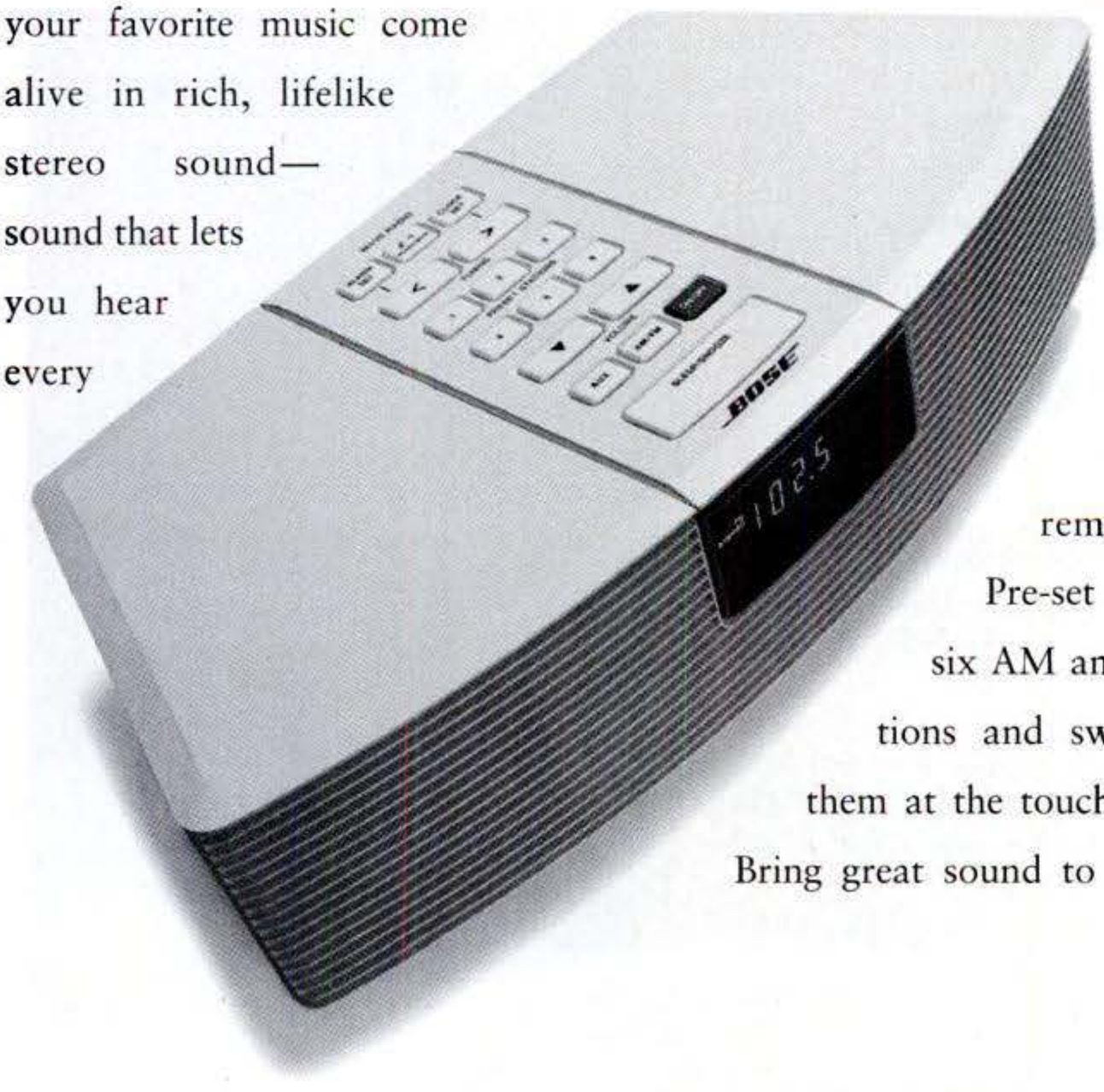
Touch a button and hear your favorite music come alive in rich, lifelike stereo sound—sound that lets you hear every note the way it's *meant* to be heard. Which is why it's well worth $349. No matter what kind of music you enjoy,



the Wave® radio will truly increase your listening pleasure. Consider that *Popular Science* honored the Wave® radio with a "Best Of What's New" award. *BusinessWeek* named it a "Best New Product of 1994." And since it's small enough to fit almost anywhere, you can listen in your bedroom, living room, kitchen, or any room.

Great sound made easy.

In addition to great sound, we built in an array of easy-to-use features no other radio gives you. Operate the radio from across the room with the credit card-sized remote control. Pre-set your favorite six AM and six FM stations and switch between them at the touch of a button. Bring great sound to your favorite recordings by connecting the Wave® radio to your CD or cassette player. Or connect your TV or VCR to make your favorite programs and movies come alive.



You have to hear it.

We don't expect you to take our word for how good the Wave® radio sounds. You really have to hear it to believe it. The Wave® radio is available directly from Bose. Use the toll-free number or the coupon to request more information. Or call to try out the Wave® radio in your home for fourteen days, satisfaction guaranteed. If you love it, keep it. If not, return it for a refund of the purchase price.

Call 1-800-845-BOSE, ext. RP293, or send the coupon today.

You've had a lot of radios—small radios, portable radios. It's time you owned the best-sounding radio—the Bose Wave® radio.

Call 1-800-845-BOSE, ext. RP293.

Mr./Mrs./Ms. _____
Name (Please print)

Address

City State Zip

( ) ( )
Daytime telephone Evening telephone

Mail to: Bose® Corporation, Dept. CDD-RP293, The Mountain, Framingham, MA 01701-9168, or fax to 508-485-4577.

© 1995 Bose Corporation. Covered by patent rights issued and/or pending. Price is subject to change without notice.

This One
PK5Y-3FU-Q2QK

Copyrighted material

READERS TALK BACK

Other Fish To Fry

We enjoyed your story about Sylvia Earle and admire her contributions to oceanic science ["Queen of the Deep," April]. Aquaculture is indeed providing a larger share of fish consumed around the world. Now 23 percent of the fish eaten by humans comes from fish farms. The oceanic catch has declined, but better management should increase future yields. The stories about $30,000 bluefin tuna get kicked around a lot, but few specimens reach that level—just like the fact that the price for blue-ribbon steer is higher than for run-of-the-mill cattle.

Lee J. Weddig
Executive Vice President
National Fisheries Institute
Arlington, Va.

The Human Ecosystem

Aliens Among Us" [May] defines an alien species as "any organism introduced into an environment in which nature hadn't intended it to be." But nature doesn't *intend* species of distinct environments to remain separate; rather, organisms constantly shift, and in the mingling, through natural selection, may perish, thrive, or evolve. Humans can't intrude into this chain of life—because we are a part of it.

Eugene Kim
Ridgewood, N.J.

Mistaken Identity

The creature you identify as a "ghost" shrimp in your May FYI section is really a stomatopod. It is nicknamed the mantis shrimp because its two appendages recall the Praying Mantis insect. Incidentally, smaller stomatopods make attentive and colorful pets in marine aquariums—provided they are not kept with small fish.

Phil McGillivary
Lake Ridge, Va.

Getting Sea Power Underway

In 1971 I and others built a small sea-power plant in the Antarctic. It utilized the temperature difference between the bottom warm water and the cold surface-air temperature—in contrast to the warm surface and cold deep water used by the Ocean Thermal Energy Conversion project in Hawaii ["Sea Power," May]. We produced only 300 watts, but we did prove the theory and learned a great deal; lack of financing prevented further development. There are a great many such stories to be told since Jacques Arsene d'Arsonval in 1891 first conceived of this sea-power idea. Surely our patience of over a century will be rewarded soon!

Robert B. Thomson
Retired Director, Antarctic Division
Department of Scientific and
Industrial Research
New Zealand

Historically Speaking

In "Jet Fighter" [Looking Back, April], you state that the turbojet engine was first conceived and produced in Germany. It's true that the first jet aircraft produced was a German Heinkel, making its maiden flight in 1939. But Frank Whittle, a British aviation engineer, invented the jet engine in 1930. The British first put it into a plane in 1941, when the Gloster Whittle E28 flew.

Iain Brown
St. Albans, Herts
United Kingdom

Reinventing The Fan

In "Concepts on the Edge" [April], Oldsmobile claims that the Antares interior oscillating fan is a new concept. However, my 1985 Mazda 626LX has an oscillating fan on the center vents.

Daniel Hall
Greensboro, N.C.

Wave Of Opinion

I found more of interest in the Goodyear and K-Mart ads than in the May issue on oceans.

Dennis Willcox
Lake Isabella, Calif.

Simply putting the name POPULAR SCIENCE on the cover does not fulfill your obligation to readers. The May issue was not the magazine I subscribe to.

David C. Jahnke
Wisconsin Dells, Wis.

I'm happy you devoted a whole issue to the oceans. I feel more aware of the problems that humans have created—and I think many other people are too.

Brian Kubit
Brecksville, Ohio

Battling Buildup

In Automotive Newsfront [April], you incorrectly state that STP tested reformulated gasoline, or RFG, on cars over the last two years. STP's testing was conducted with oxygenated fuels, which are similar but not the same as RFG. We started testing RFG in January, when it first became available.

Roger Littlejohn
STP Products
Danbury, Conn.

In your RFG report you state, Toyota Camrys "seem immune to the deposit problem, while Chevy Luminas build up deposits quickly." Which model years were tested? Does the Pontiac 3.1-liter V6, which uses the Lumina engine, have buildup problems as well?

Albert R. Alter
Cheltenham, Pa.

You will likely experience similar buildup problems in cars that share the same engine. STP tested domestic and foreign cars from model years '91, '92, and '93, with engines ranging from four cylinders to V8s. Specific engine information is not available from STP.—The editors

Ask Popular Science

- *How does an automotive airbag operate?*
- *How many more years will our sun continue to burn?*

POPULAR SCIENCE will answer your science and technology questions in a new section to premiere this year.

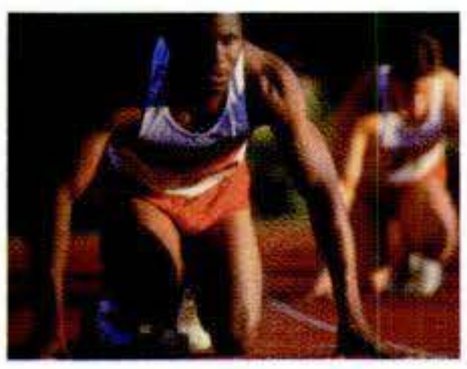
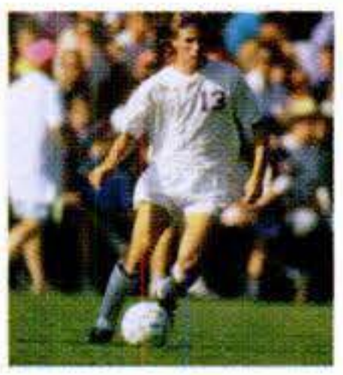
Mail questions to: Ask Popular Science
Popular Science
2 Park Ave.
New York, NY 10016
E-mail (from any online service) to our Internet address:
AskPopSci@aol.com
Or fax us at: (212) 481-8062

Sorry, but only letters chosen for publication can be acknowledged or answered.

Address your letters to Readers Talk Back, POPULAR SCIENCE, 2 Park Ave., New York, N.Y. 10016; fax them to 212-481-8062; or send electronic mail to AskPopSci@aol.com. The letters may be edited for space and clarity. Due to the volume of mail, we regret that we cannot answer unpublished letters.

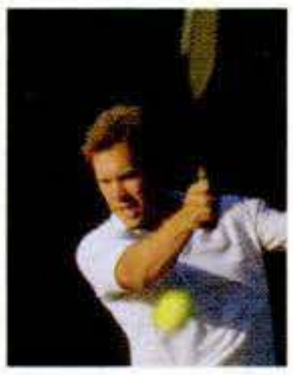
Copyrighted material

SPORTS ENTHUSIAST:

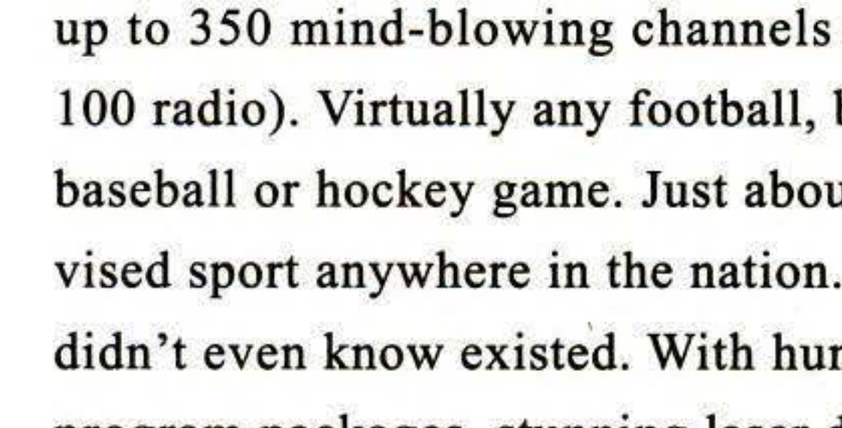
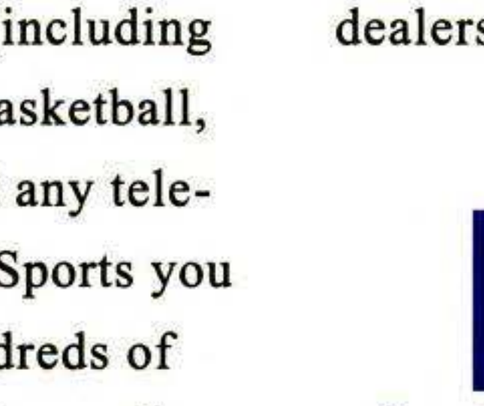



SOMEONE WHO FIGURES

350 STATIONS MAY



BE ENOUGH TO GET

THROUGH A SUNDAY.

There's nothing more important in the world than sports. Nothing. Not even breathing. And that being the case, it's simply your destiny to own a Full View satellite TV system. It gets up to 350 mind-blowing channels (including 100 radio). Virtually any football, basketball, baseball or hockey game. Just about any televised sport anywhere in the nation. Sports you didn't even know existed. With hundreds of program packages, stunning laser disc quality picture and CD quality sound. So look, call **1-800-778-4900** now for the nearest authorized Full View TV dealer, a free brochure and free basic installation at participating dealers. Oh, and remember to do it by Sunday.

FULL VIEW TV™

THE SATELLITE SYSTEM WITH THE BEST VIEW

Copyrighted material

From 0 to 60
With four sets of

And we're not talking about Sunday bags, either. But even with all that room, the 1995 Chevy Impala SS behaves less like a typical luxoboat than a swoopy 2+2—and just try squeezing three of your best-fed golfing buddies and their sticks into one of those. To help improve your lie, we outfitted Impala with beefy 17-inch BFGoodrich® Comp T/A® tires,

For a brochure call 1-800-950-2438. The Chevrolet Emblem and Impala are registered

Copyrighted material

in 7.4 seconds. clubs in the trunk.

massive disc brakes all around and a rear suspension straight out of *Tales of the Highway Patrol*, including de Carbon gas shocks, steel springs and anti-roll bars. But honestly, is the Impala SS really that fast? Let's put it this way: you'll never miss another tee time.

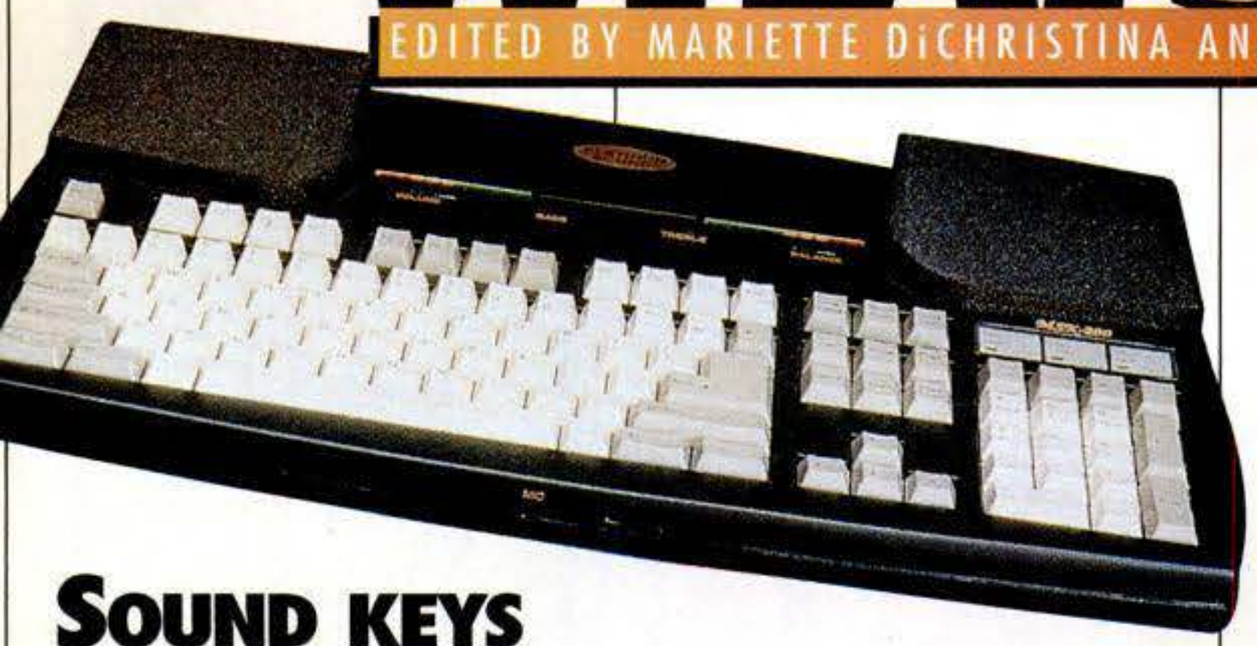
IMPALA SS GENUINE CHEVROLET™

trademarks and Chevy is a trademark of the GM Corp. ©1994 GM Corp. All Rights Reserved. Buckle up, America! ■

Copyrighted material

WHAT'S NEW

EDITED BY MARIETTE DiCHRISTINA AND SUZANNE KANTRA KIRSCHNER

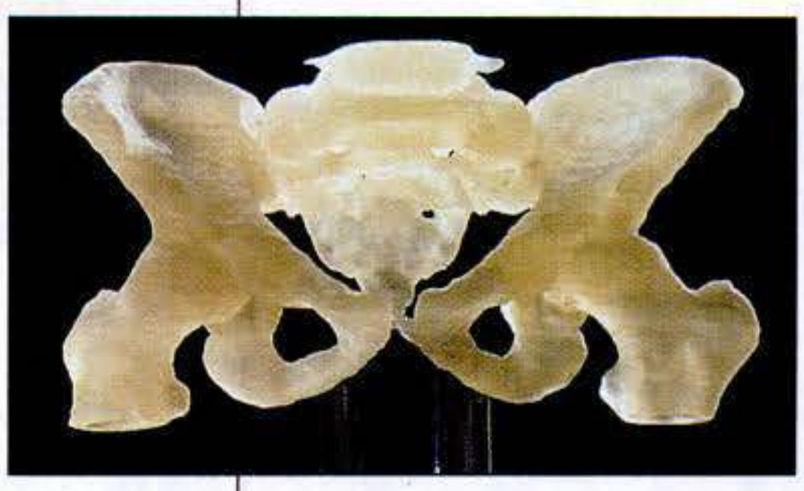


SOUND KEYS

A conventional computer keyboard is fine for typing text, but the MSK-200 Multimedia Stereo Keyboard also lets you play back the sound tracks of interactive games and other programs. The 20-watt speakers are more powerful than most keyboard speakers and have separate controls for volume, bass, treble, and balance settings. The $230 keyboard works with multimedia PCs. SC&T International, 3837 E. LaSalle St., Phoenix AZ 85040.

POSTCARD FROM SPACE

The orbiting Hubble Space Telescope recently sent back this image of Mars, the sharpest picture of the red planet ever taken from Earth's vicinity. The wispy white clouds, composed of ice crystals, are an indicator that the martian atmosphere is considerably cooler than when the unmanned Viking spacecraft visited the planet in the mid-1970s. Researchers attribute the cooling to diminished dust storms.



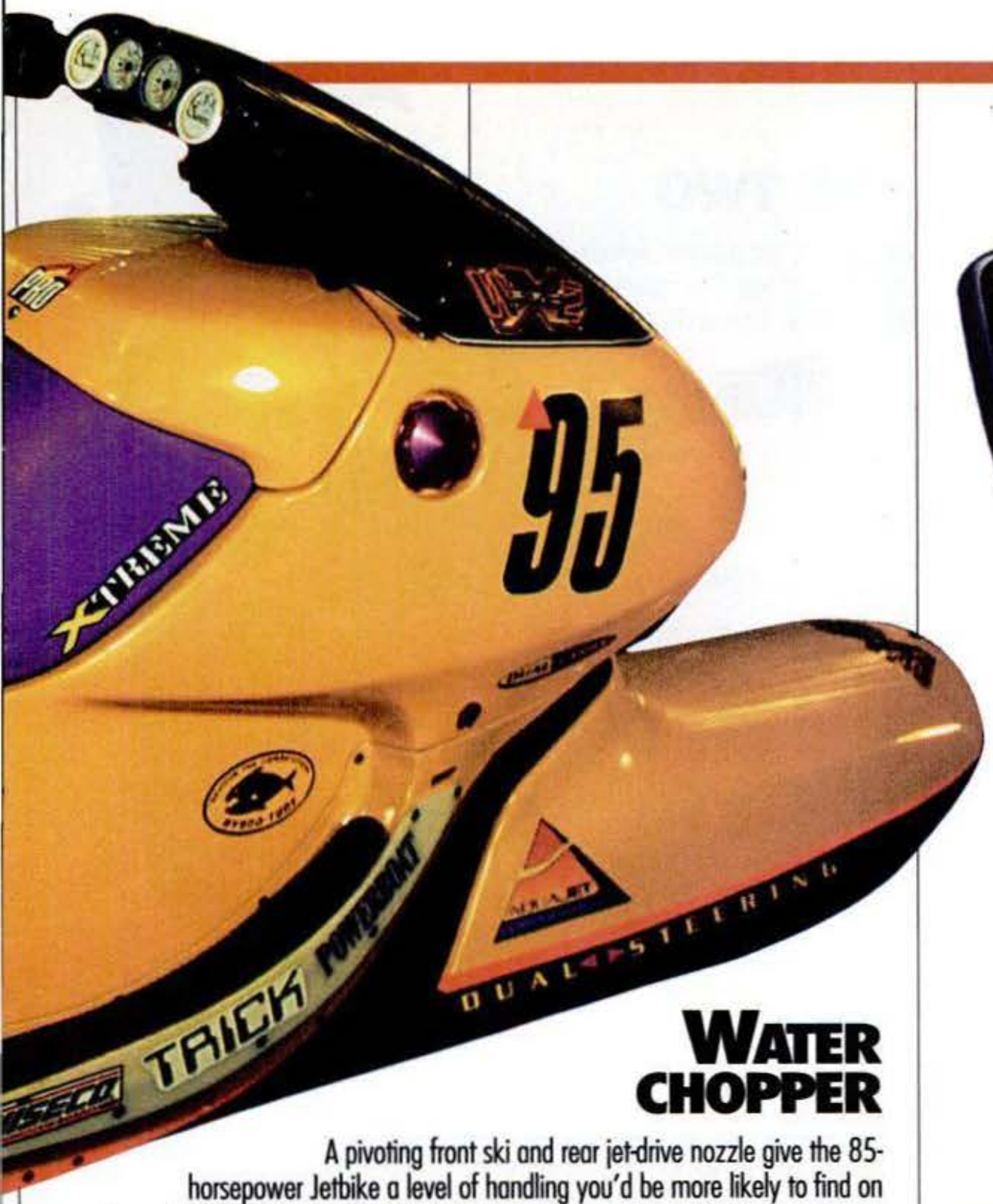
MEDICAL MACHINING

The fusion of medicine and manufacturing has begun: Surgeons at the Munich-Grosshadern University Clinic are working with engineers and computer experts at the BMW Research and Development Centre in Munich to make human replacement parts. They combine computer-tomography medical scans and stereolithography, an "instant prototyping" technique, to create polymer parts, including a human pelvis (shown), spines, and jawbones. The parts have been used in experimental surgery in Europe.

DIZZY WITH SPEED

Vertigo, a wisp of a sports car custom-made by French designer Tony Gillet in collaboration with Ford, zooms from 0 to 100 kph (62 mph) in 4.5 seconds and maxes out at 250 kph (155 mph). It achieves this amazing pickup using an ultra-lightweight carbon-fiber chassis in combination with a 217-horsepower turbocharged, 2.0-liter four-cylinder engine. Available in Europe, Vertigo starts at the equivalent of $118,000.

Copyrighted material

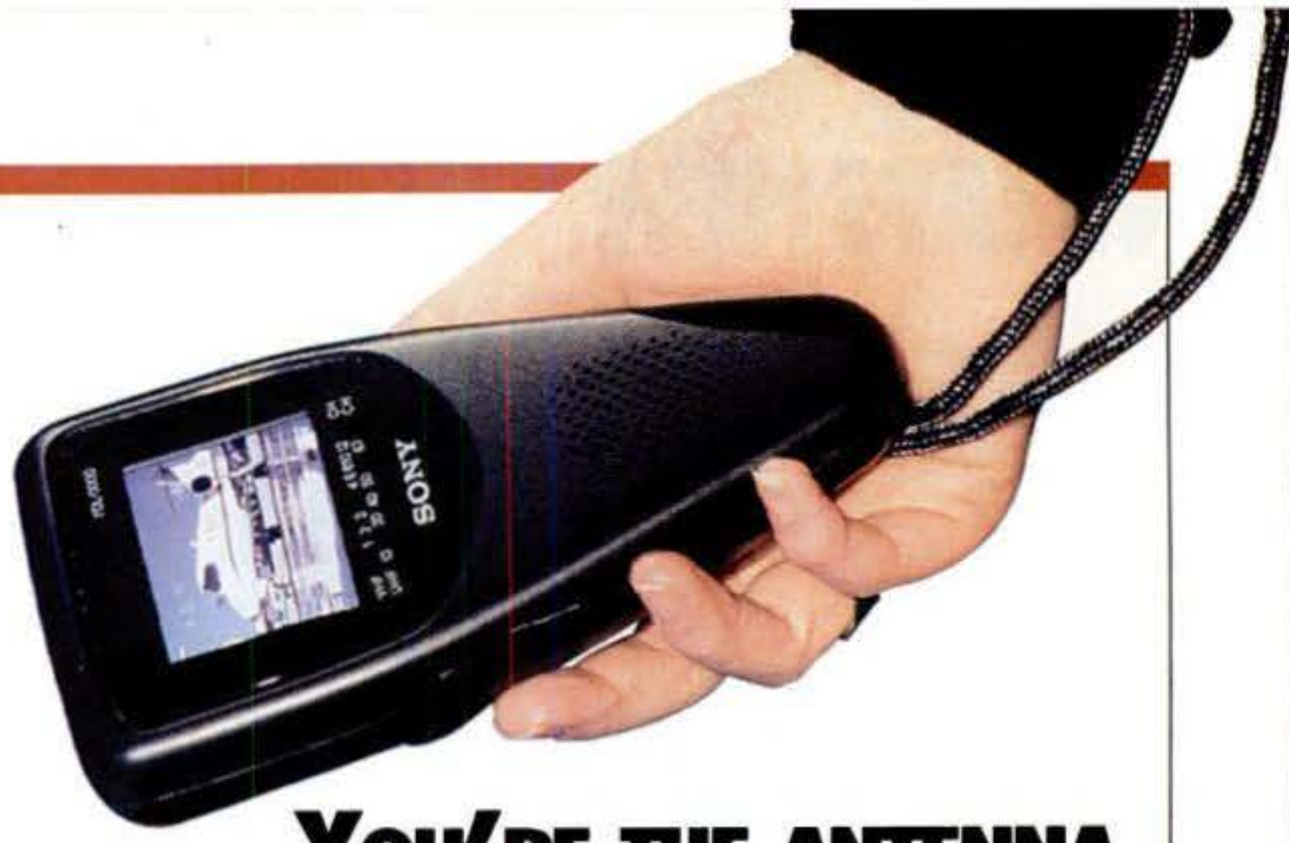


WATER CHOPPER

A pivoting front ski and rear jet-drive nozzle give the 85-horsepower Jetbike a level of handling you'd be more likely to find on a motorcycle. The 275-pound Jetbike's low center of gravity and in-line mid-mounted engine also aid in balance and control. Price: $6,995 ($8,495 for 110-hp model). Aquajet Corp., 400 N. Marine Ave., Wilmington CA 90744.

CLEAN MACHINE

Drop an electric powertrain into a mild-mannered Honda Civic hatchback and you have CUV-4, Clean Urban Vehicle 4. The prototype vehicle's solid package of standard features includes a three-speed automatic transmission, air conditioning and heater, ABS, and dual airbags. However, the speed tops out at 80 mph, the driving range is 40 to 70 miles, and it takes six to eight hours to recharge the lead-acid batteries fully.



YOU'RE THE ANTENNA

Dangle this Sony Watchman color TV from your neck and see the reception improve. After all, the human body is a natural radio receiver. The $160 Straptenna neck-strap/antenna enables hands-free operation, a real plus when leaping to your feet at a stadium. Weighing ten ounces, the FDL-22 features a 2.2-inch color LCD screen with speaker and headphone jack.

ELECTRONIC GRILL

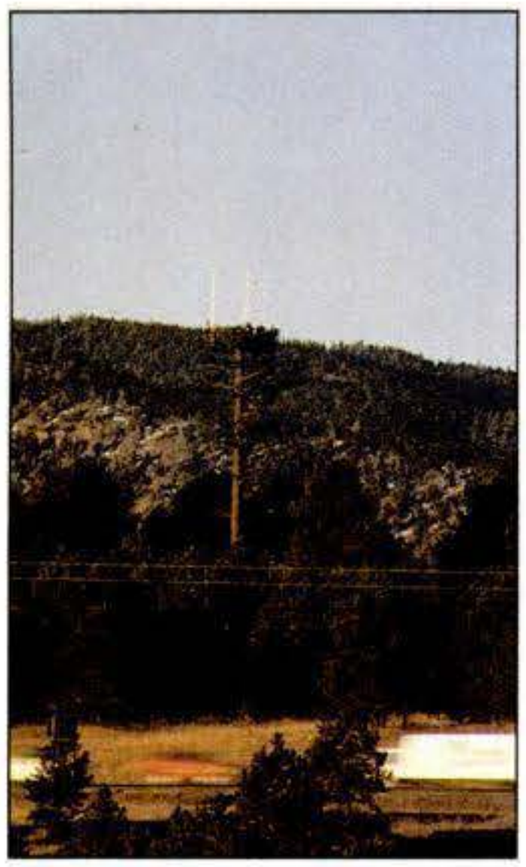
The TouchLite gas grill combines the convenience of a microwave-oven keypad with the safety controls of an indoor gas furnace; if no flame is detected during startup, TouchLite shuts the gas valve, purges the gas, and tries again. The self-cleaning grill also turns off automatically when cooking time runs out. Cost: about $500 to $800, depending on model. Convenience Technologies, 11115 Kenwood Rd., Cincinnati OH 45242.

YOGA CHAIR

Lean back in the Flogiston Chair to experience the neutral-body posture of astronauts in space and the *savasana* yoga position for meditative relaxation... at the same time. NASA uses the Flogiston Chair to simulate zero gravity; it minimizes internal and external stress, so your muscles are in equilibrium. Price: $2,800. True Dimensions, 3925 W. Braker Lane, Austin TX 78759.

Copyrighted material

WHAT'S NEW

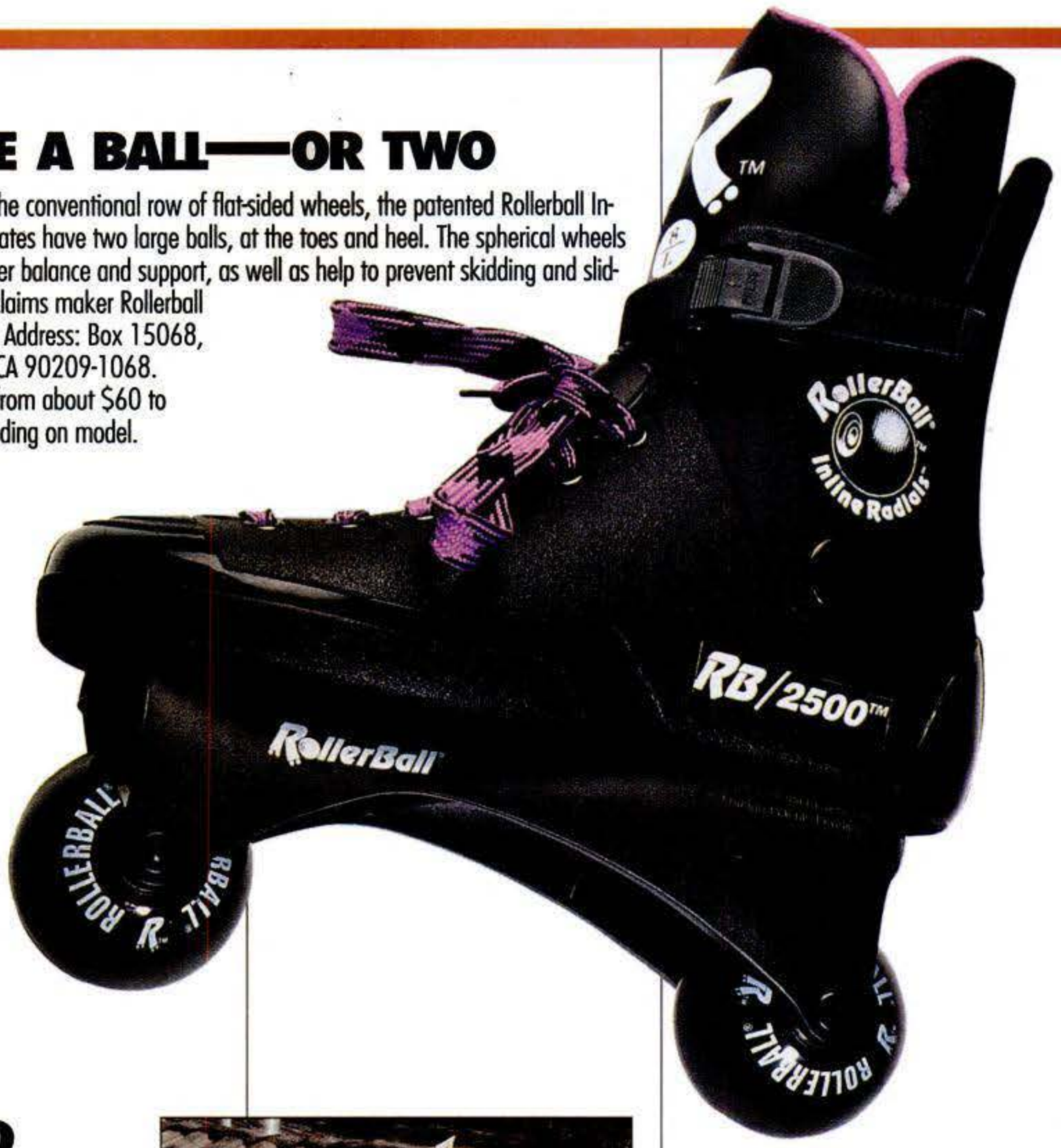


MASTER OF DISGUISE

It may not fool a woodpecker, but Tree Poles from Valmont Industries of Valley, Neb., are designed to camouflage the fact that you're looking at a cellular-telephone tower. This 60-foot "white pine" is a galvanized steel pole covered by an epoxy "bark" that has polyvinyl-chloride plastic "limbs." A "palm tree" version is next.

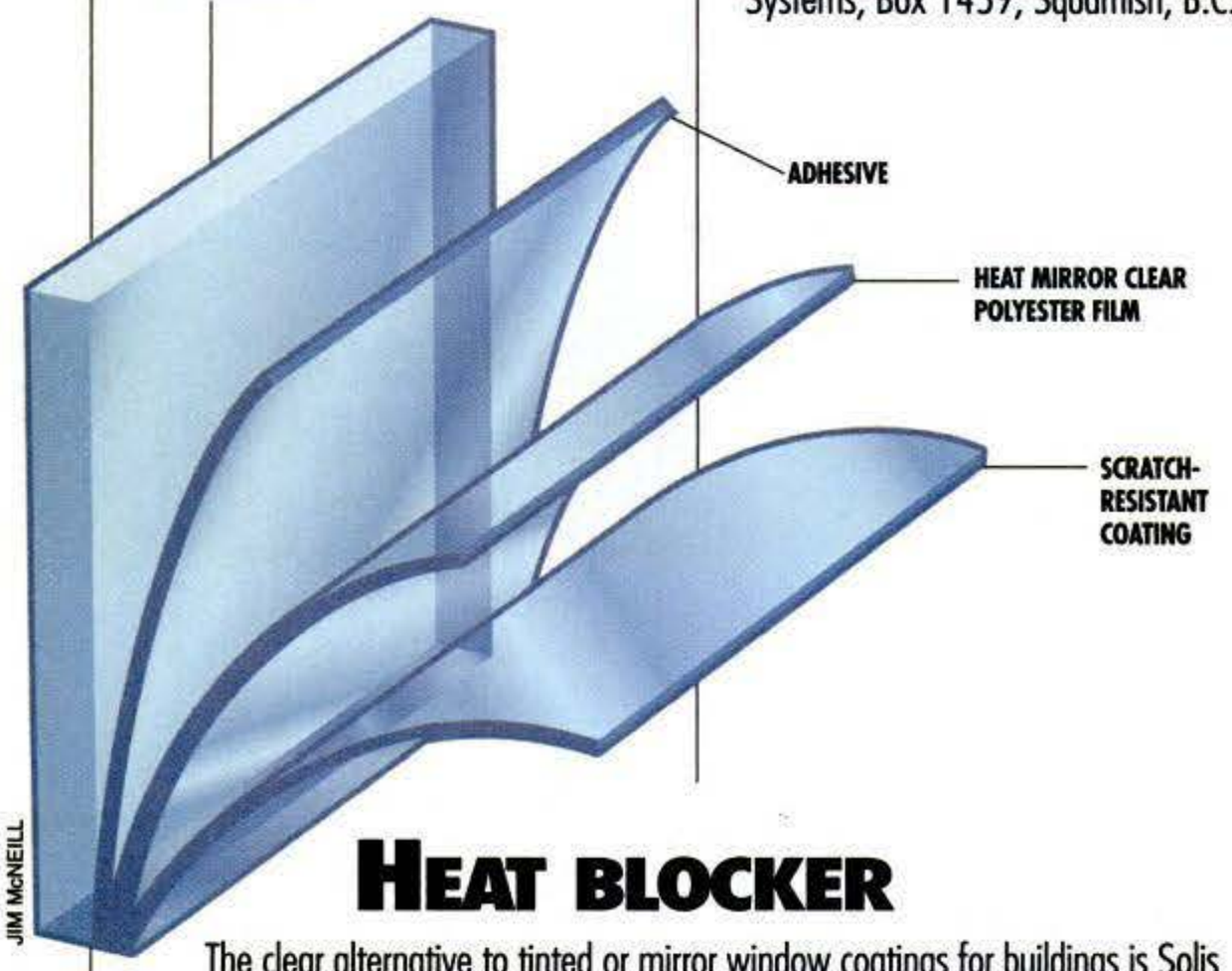
HAVE A BALL—OR TWO

Rather than the conventional row of flat-sided wheels, the patented Rollerball Inline Radial skates have two large balls, at the toes and heel. The spherical wheels provide greater balance and support, as well as help to prevent skidding and sliding in turns, claims maker Rollerball International. Address: Box 15068, Beverly Hills CA 90209-1068. Prices range from about $60 to $120, depending on model.



TIRED ROOFS

While trying to help his daughter devise innovative uses for old tires for a school project, Richard Moore, a roofer, saw the light: Now he cuts the sidewalls off old tires and uses them—in 50-inch lengths—as roofing. Cost: about $1.50 per square foot of roof, installed. Moore Enviro Systems, Box 1459, Squamish, B.C., Canada V0N 3G0.



JIM McNEILL

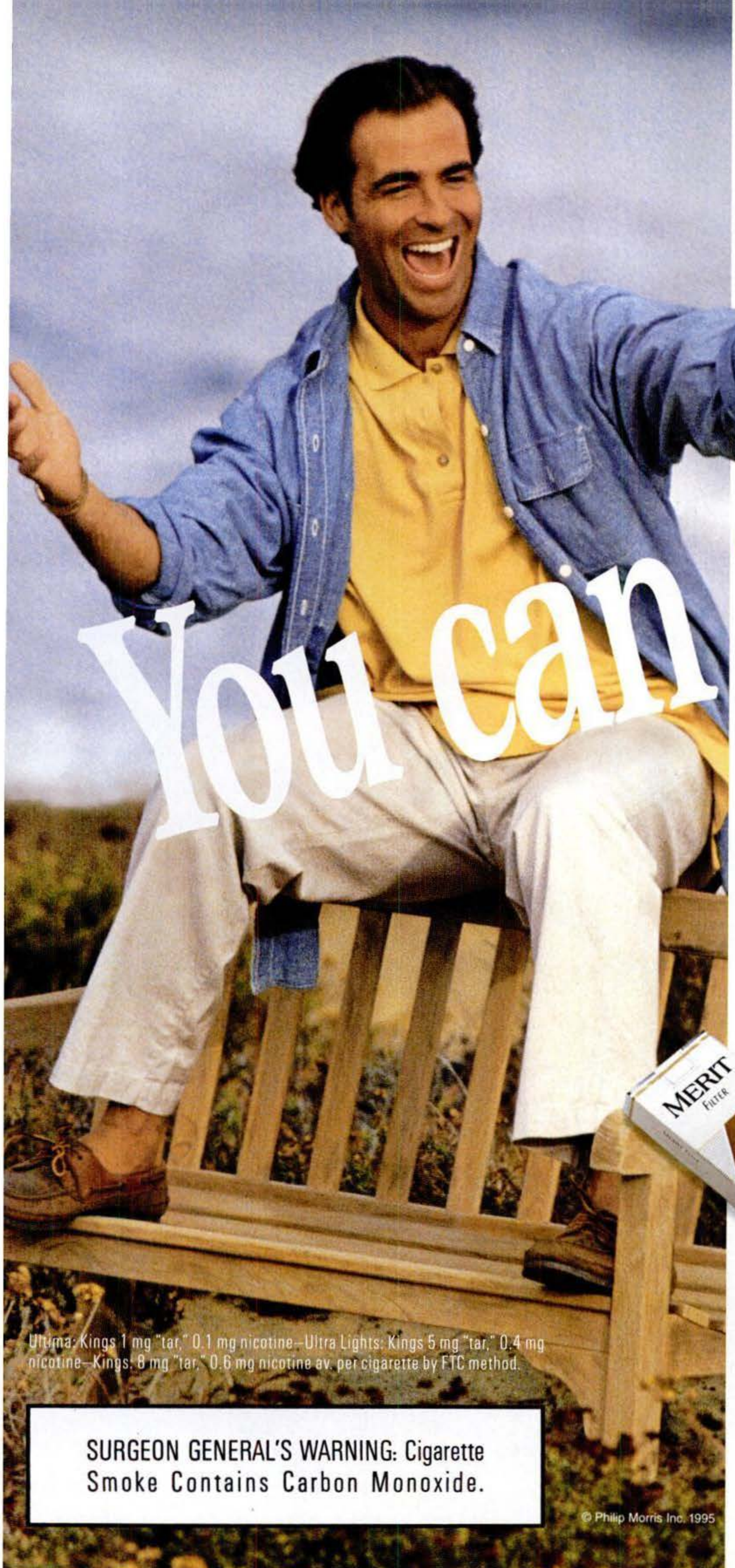
HEAT BLOCKER

The clear alternative to tinted or mirror window coatings for buildings is Solis Clear Heat Control. The colorless polyester film cuts heat gain by up to 55 percent—saving on cooling bills and blocking ultraviolet rays that fade fabrics. Manufactured by Southwall Technologies of Palo Alto, Calif., the film has an adhesive on one side for retrofitting to existing structures. The price of $5 to $7 per square foot includes installation.

V IS FOR VELOCITY

Ford's sporting version of the Taurus sedan will be powered by a new aluminum 32-valve 3.4-liter V8 engine that has an unusual 60-degree-angle "V." The 225-horsepower V8 was jointly developed by Ford and Yamaha Motor Corp., the Japanese company that produces today's SHO V6. The SHO includes a semi-active suspension that alters shock settings. The additions and luxury interior should put the price of the SHO in the $30,000 range.

Copyrighted material



There's no doubt about it. You can switch down to lower tar and find satisfying taste.

You've got MERIT

Ultima: Kings 1 mg "tar," 0.1 mg nicotine–Ultra Lights: Kings 5 mg "tar," 0.4 mg nicotine–Kings: 8 mg "tar," 0.6 mg nicotine av. per cigarette by FTC method.

SURGEON GENERAL'S WARNING: Cigarette Smoke Contains Carbon Monoxide.

© Philip Morris Inc. 1995

Copyrighted material

© 1995 Canon Computer Systems, Inc. Canon and BJC are registered trademarks and Bubble Jet is a trademark of Canon Inc. CCSI, 2995 Redhill Ave., Costa Mesa, CA 92626. In Canada, call 1-800-263-1121, Ext. 959.

Copyrighted material

Your idea of an office has changed.

Your idea of great color hasn't.

The BJC-70 COLOR BUBBLE JET PRINTER

These days your office is likely to be wherever you happen to work. The bedroom. The boardroom. The backyard. And that work better be spectacular. So your printer has to go everywhere you do, producing brilliant color and true black output that's absolutely top drawer.

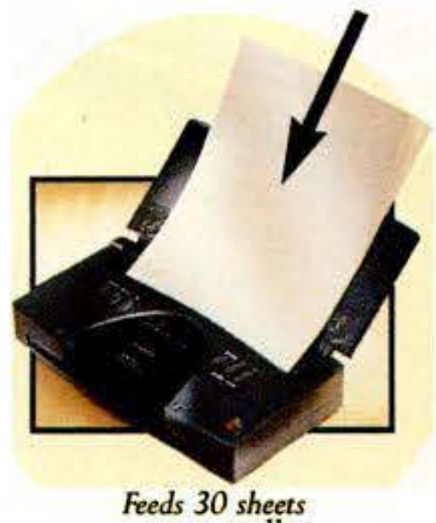
That's the beauty of the BJC-70 Color Bubble Jet™ Printer from Canon®. First, you get 720 x 360 dpi resolution (really crisp quality) and 4 page-per-minute laser speed in black and white. On top of that you get bright, vibrant colors.

Sharp, fast, brilliant colors and true blacks.

All in one sleek, cool, economical little package.

But don't let the size fool you. The BJC-70 auto-feeds 30 sheets at a time. And it's so rugged we offer a two-year limited warranty including free InstantExchange.

Naturally, it's as easy to use as it is to carry.



Feeds 30 sheets automatically.

It even comes with our Color Advisor software that automatically picks the colors that make you look your best.

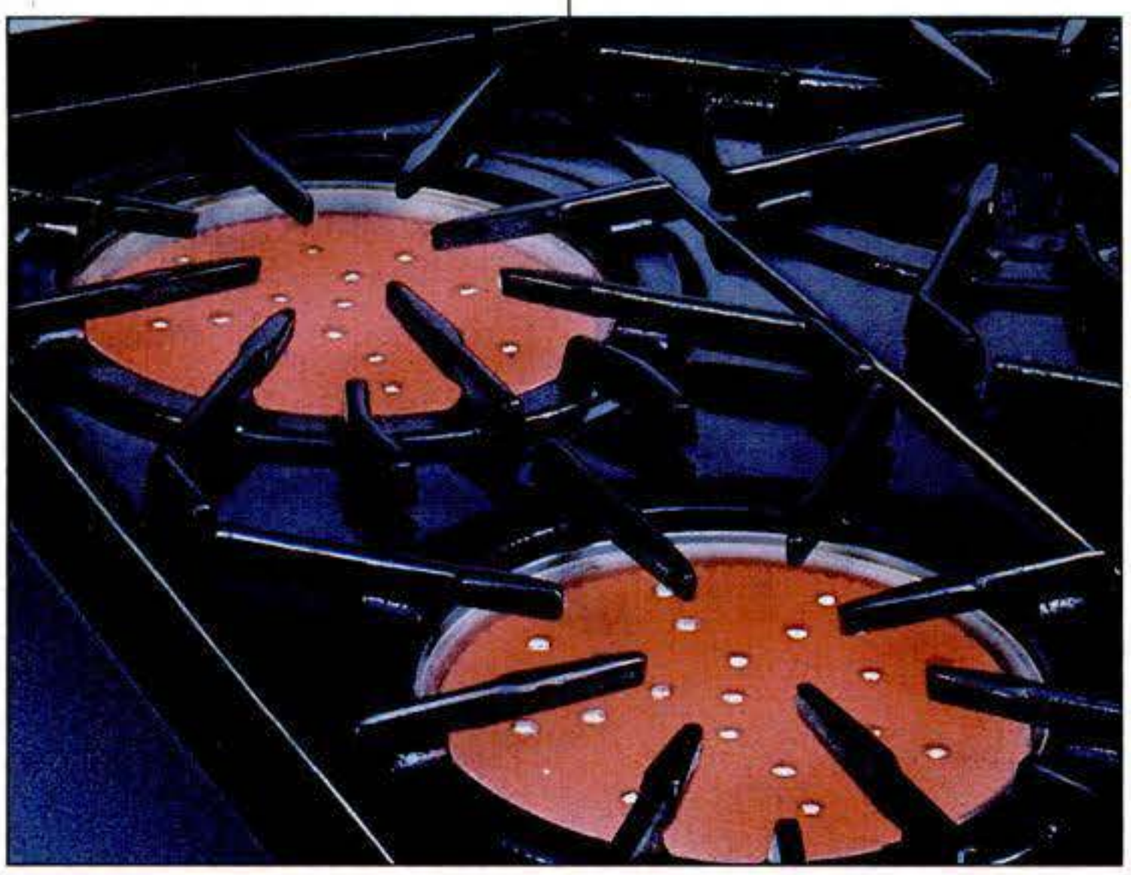
So give us a call at 1-800-848-4123, Ext. 959.

Because the BJC-70 Color Printer is going to be giving you all kinds of new ideas.

Canon

Copyrighted material

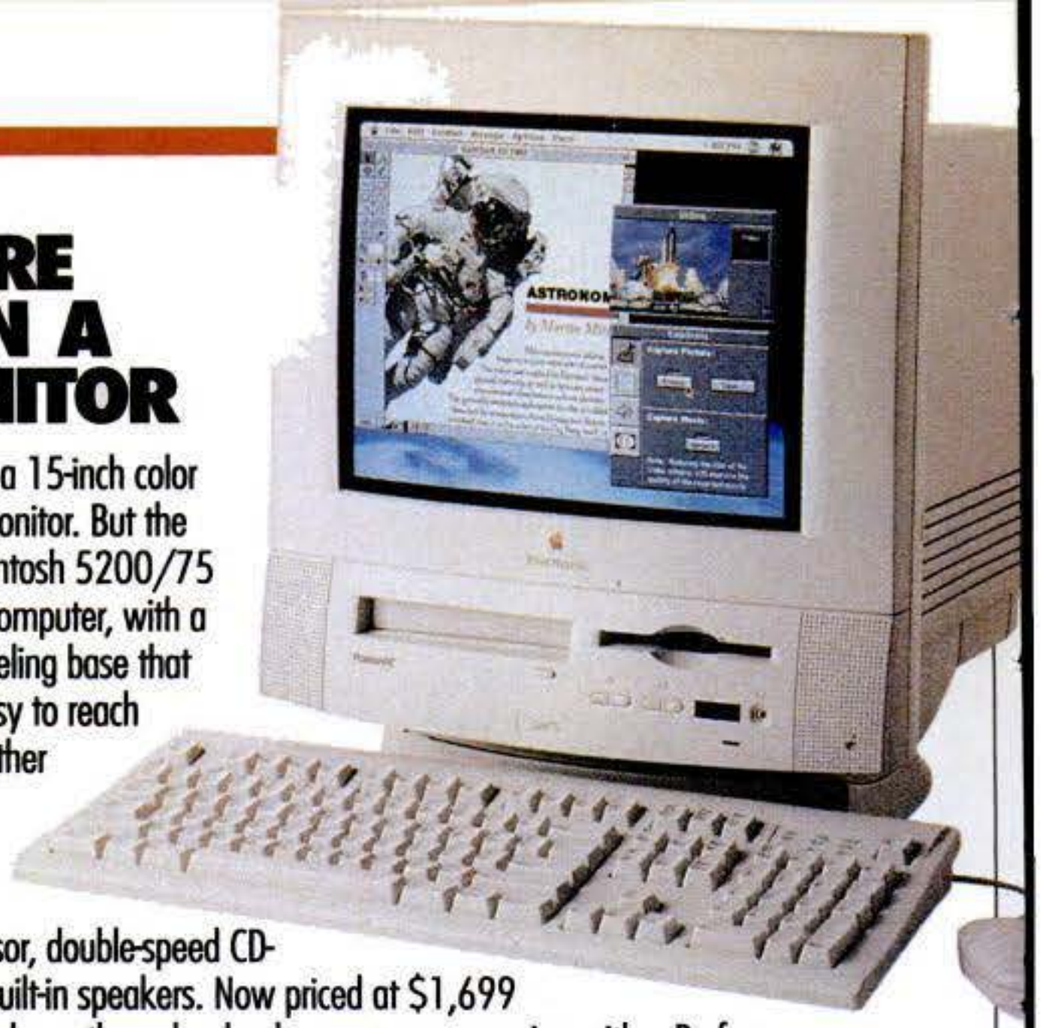
WHAT'S NEW



NO-FLAME GAS RANGE

Prototype IR-Jet gas burners built by Wolf Range of Compton, Calif., have no open flame: Instead, the flame heats a perforated glass-ceramic plate. The resulting convective heat energy jets upward through the plate's holes. Adding convective heating to a regular gas range's radiant-heat transmission halves the time normally required to boil water. What if food falls through the holes? It's incinerated instantly by the burners, which typically operate at 1,200°F.

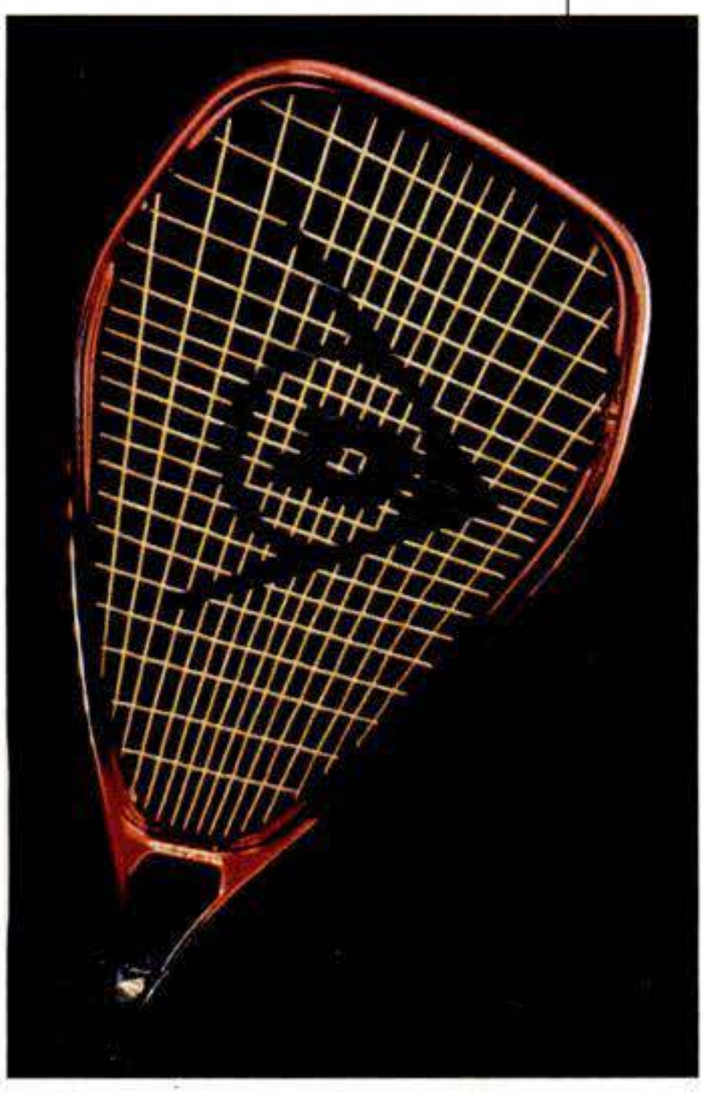
MORE THAN A MONITOR



It looks like a 15-inch color computer monitor. But the Power Macintosh 5200/75 LC is a full computer, with a unique swiveling base that makes it easy to reach the ports. Other features include a PowerPC 603 processor, double-speed CD-ROM, and built-in speakers. Now priced at $1,699 for purchase by or through schools, a consumer version with a Performa model name will be available this summer.

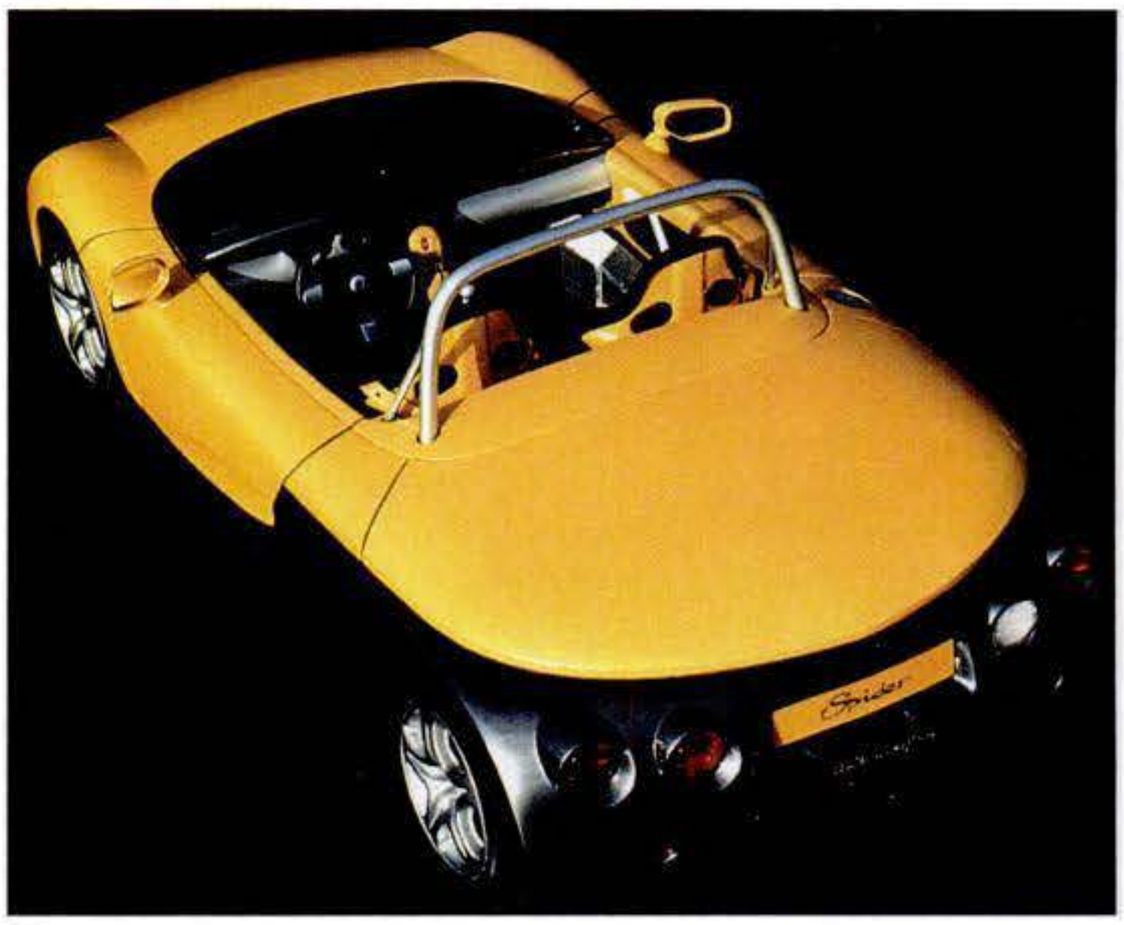
EASY GRIP

For those difficult-to-turn fasteners, the Ratcheting Screwdriver/T-Handle's jointed handle forms a 60-degree angle, creating an easy-to-grip "T." The reversing mechanism can be operated with one finger. Price for the driver with a bit adaptor and quarter-inch drive socket: about $55. SK Hand Tool Corp., 3535 W. 47th St., Chicago IL 60632-9969.



POWER TOOL

It's the biggest tennis racket available to date: Dunlap's Max Predator sports an amazing 125-square-inch diamond-shaped head, a 1.2-inch-thick wide-body frame, and the largest sweet spot on the market, the company claims. Amazingly, it still lets you retain a semblance of control...but you never forget you could easily hit the ball into the next county. List price: $190.



LIGHT AND SPEEDY

The first production application of the Mosaic weight- and fuel-saving research program conducted by Renault and partner firms is the Renault Sport Spider. The featherweight (1,650 pounds) sports car zips from zero to 60 mph in less than six seconds and tops out at more than 130 mph. The compact two-seater has an aluminum space-frame chassis clad in molded composite body panels. Production starts in 1996; the price is expected to be about $30,000.

Copyrighted material

WHAT'S NEW

SUPERFAST MAGNETIC BEARINGS

Spinning at 36,000 rpm without any lubrication or physical contact, a magnetically suspended turbine shaft established a rotational speed record for a jet-engine component that "floats." The magnetic-bearing system comprised of microprocessor-controlled electromagnets and sensors was built by SatCon Technology Corp. of Cambridge, Mass., under an Army program to increase turbine-engine efficiency and durability. Further testing aims to achieve 50,000 rpm.

PRACTICAL—WITH PICKUP

By stuffing the high-output V6 developed for the SHO Taurus into a stock Windstar, Ford demonstrates that a family van doesn't have to be slow. The 220-horsepower engine is accompanied by a new suspension setup for high-speed handling. The concept also demonstrates the high-intensity discharge lighting system that will be introduced on the mid-1995 Lincoln Mark VIII.

FLOATING TRAIN

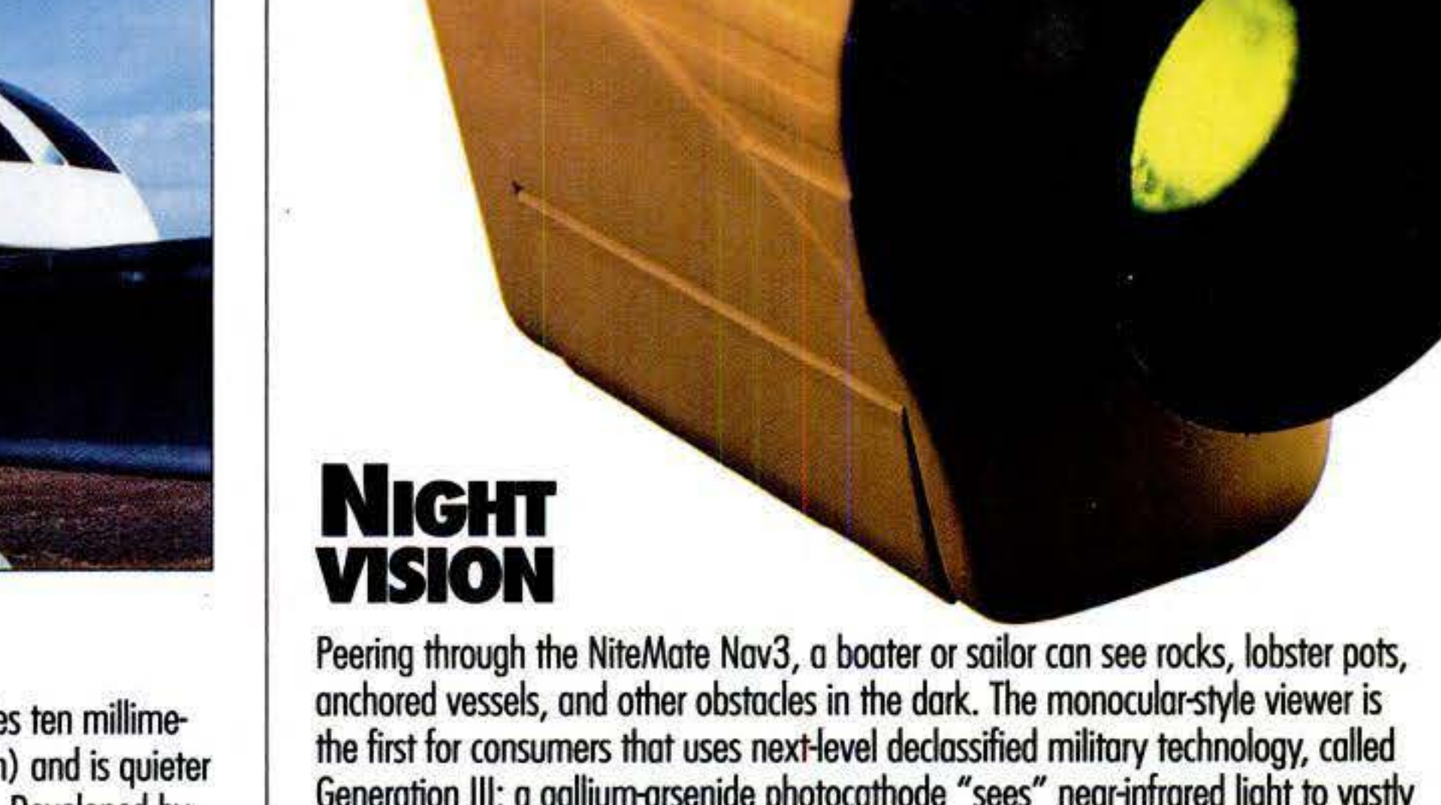
Transrapid, the world's first train propelled by a magnetic field, glides ten millimeters above its concrete track at speeds of up to 450 kph (270 mph) and is quieter than the high-speed French train, the TGV (*Train a Grande Vitesse*). Developed by the German conglomerate Thyssen, Transrapid is scheduled to make the 284-kilometer (170-mile) trip between Berlin and Hamburg beginning in 2004, upon completion of the track infrastructure.

NIGHT VISION

Peering through the NiteMate Nav3, a boater or sailor can see rocks, lobster pots, anchored vessels, and other obstacles in the dark. The monocular-style viewer is the first for consumers that uses next-level declassified military technology, called Generation III; a gallium-arsenide photocathode "sees" near-infrared light to vastly improve resolution over previous products. The $1,595 device is from Intervac, 601 California Ave., Palo Alto CA 94304-0883.

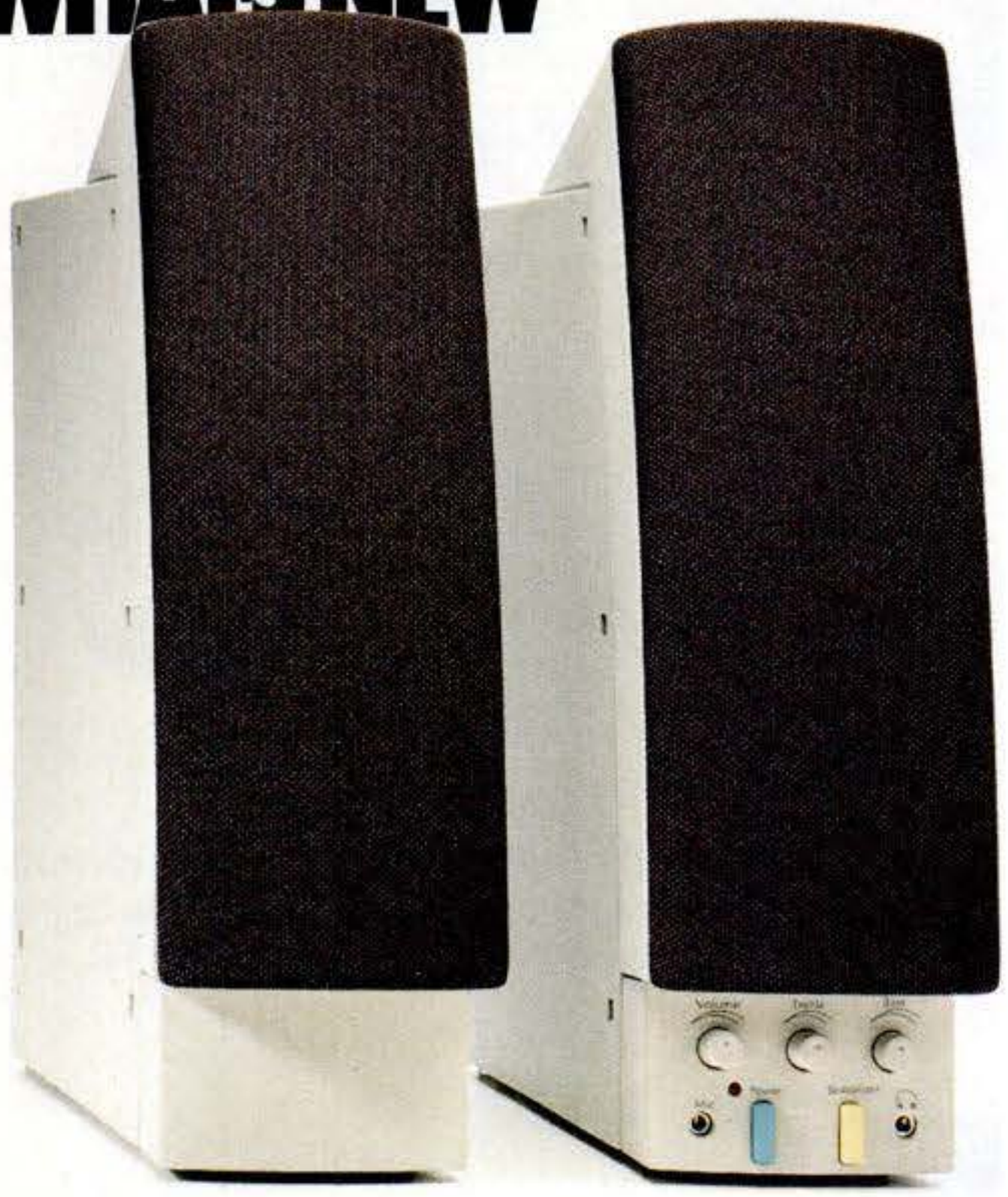
BETTER DETECTOR

COSmart is the first carbon monoxide detector to use absorption-infrared technology. The device recognizes the unique infrared "signature," called an absorption band, of carbon monoxide that diffuses into a sampling chamber. Originally developed by the military, the basic technique has been used in more expensive medical and gas-sensing instruments since the '50s. Price: about $250 to $350, depending on model. Telaire Systems, 6489 Calle Real, Goleta CA 93117.



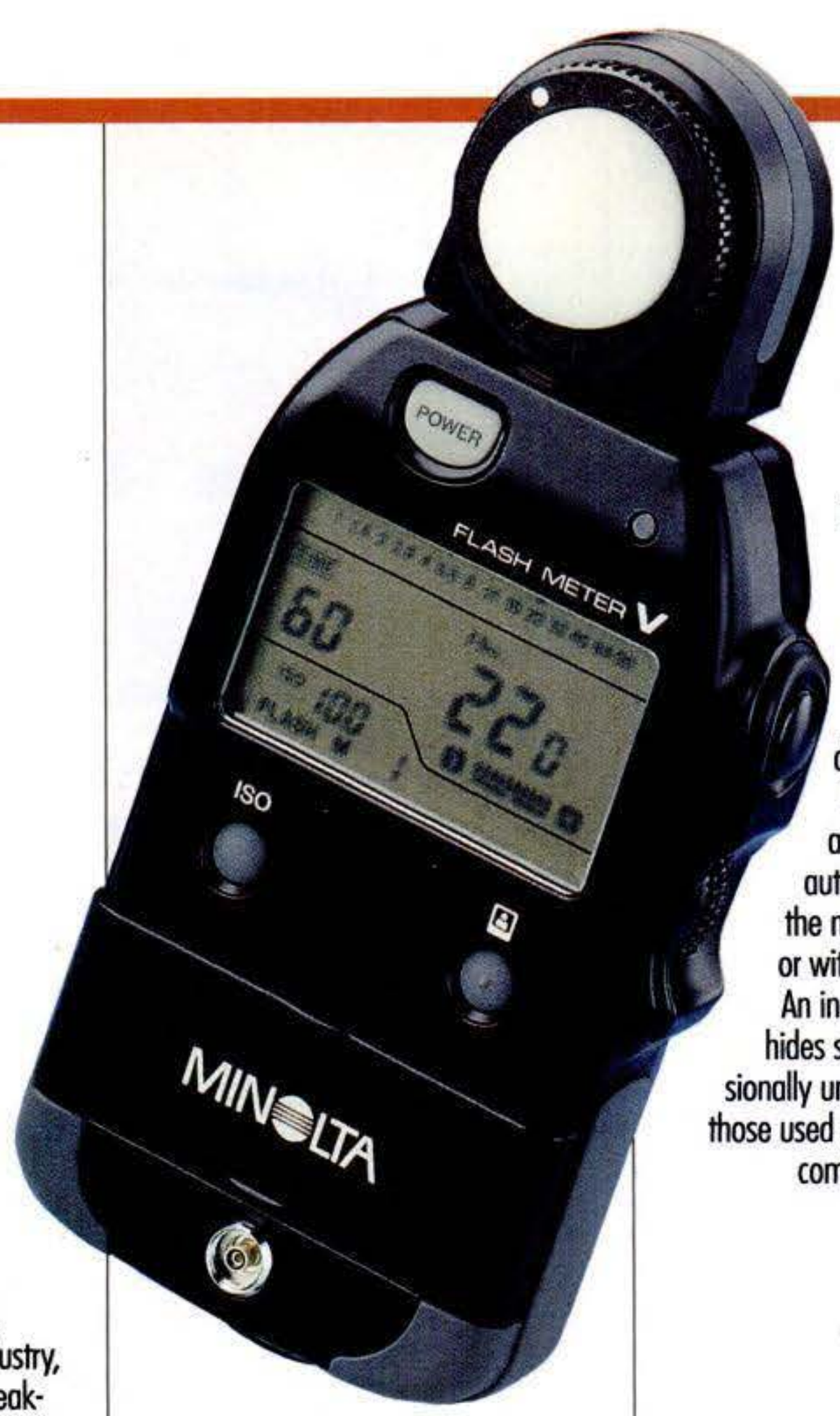
Copyrighted material

WHAT'S NEW



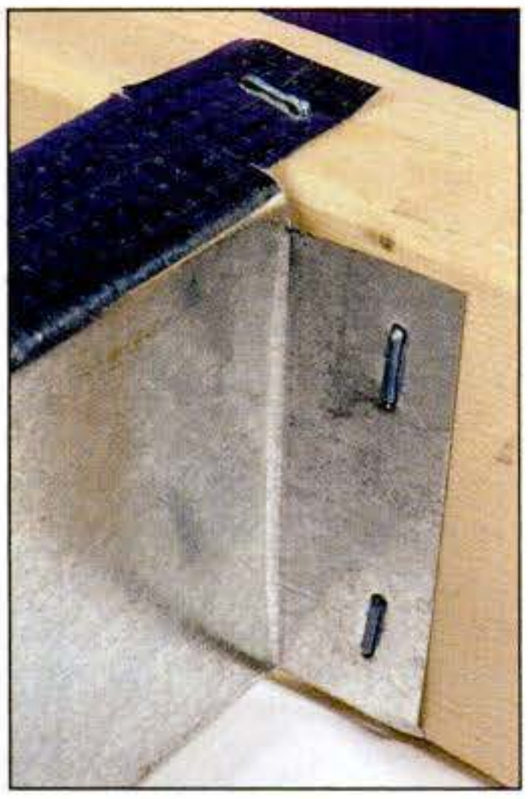
SURROUNDING MULTIMEDIA

Labtec's new multimedia speakers bring the impact of surround sound to PCs. Using the Spatializer "3-D" stereo technology developed for the recording industry, the new desktop speakers steer sounds around the listener using only two speakers. The XC-3210 speakers should be available in late August or September for about $100.



BRIGHT FLASH METER

Designed to be both super-smart and easy to use, the Minolta Flash Meter V has an unusual "intelligent" auto mode in which it can distinguish between ambient and flash light—and monitor both. It also automatically tells whether the meter is being used with or without a connecting cord. An ingenious ergonomic plan hides switches used only occasionally under a sliding cover, and those used rarely inside the battery compartment. Price: $940.



STEEL STUDS

With the price of lumber rising, many builders are turning to steel components. Now the Carpenter's Steel Stud is the first that attaches to conventional wood framing with standard tools. Unlike wood, steel won't warp, rot, or split. The stud is also made from 70 percent recycled steel, derived from automotive salvage. It costs about $0.50 to $1 less than wood per stud. HL Stud Corp., 2545 Stringtown Rd., Lancaster OH 43130.

EASY SHIFT

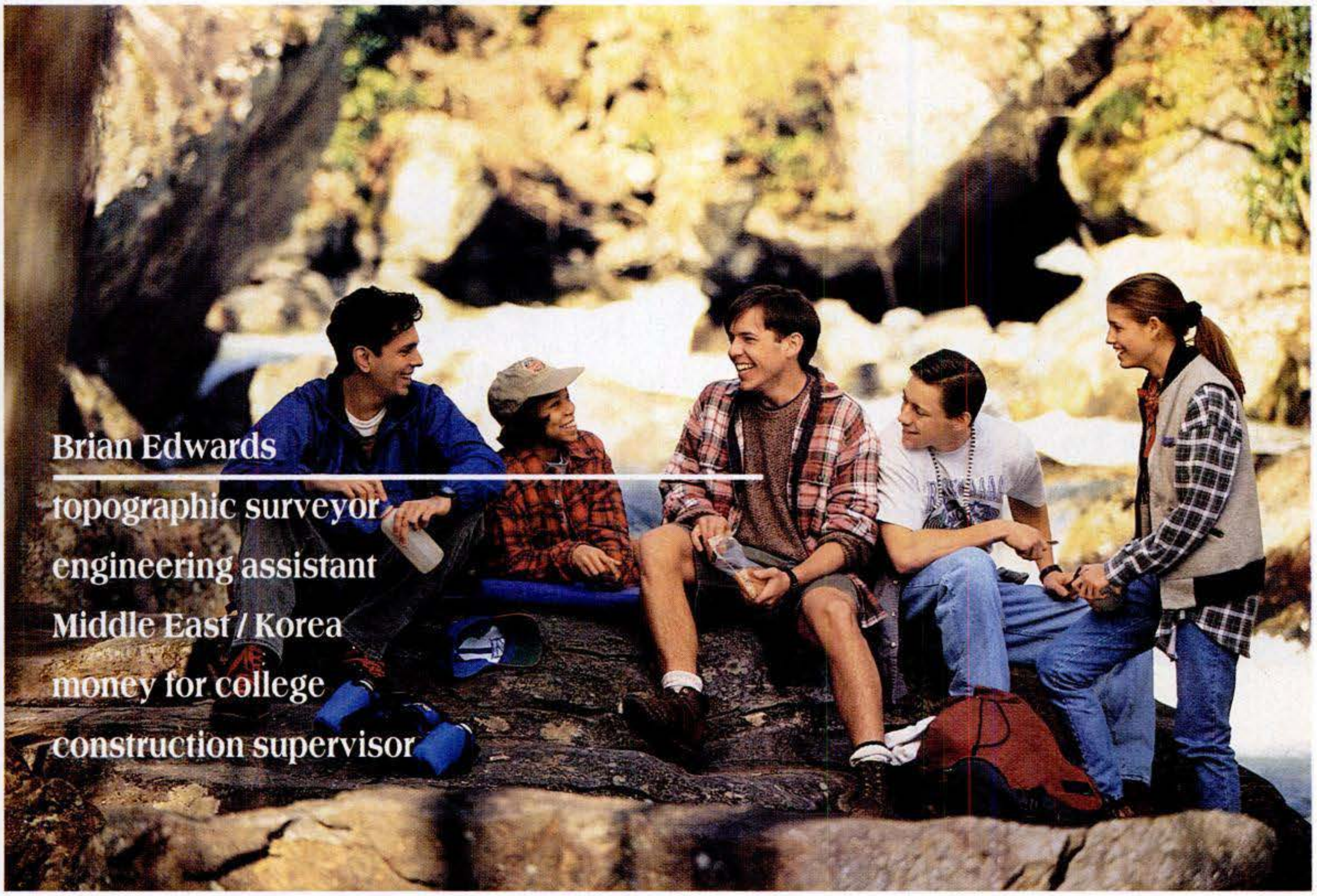
Would you like a computer-controlled six-speed automatic transmission that adjusts to your own aggressive or laid-back style? For your bicycle? Professor Bruce Arden at the University of Rochester put a team of engineering students to work on the project, and the resulting prototype takes all the skill out of shifting your derailleur. The battery-powered device monitors wheel speed and how hard you're pedaling, and shifts up or down to keep your effort constant.

REVAMPED VAN

Chevrolet has updated its full-size van for 1996, the first major change in this people and cargo hauler in 25 years. A new, rigid frame extends the wheelbase, and the spare mounts under the body for additional interior room. A turbocharged-diesel option is offered for the first time, along with a more-powerful lineup of V6 and V8 engines. The Chevy Express can be equipped to carry 15 passengers. The price is expected to be in the low $20,000 range.

Copyrighted material

IN FOUR YEARS, YOU WON'T RECOGNIZE YOURSELF.



The right choices today can make a big difference tomorrow. This year, Brian Edwards and over 375,000 ambitious young men and women will find the opportunities, training, experience and encouragement they need in the U.S. Armed Forces.

In the next four years, Brian will become a surveyor, then an engineering assistant, while serving his country in the Middle East and Korea. And he'll receive more than $14,000 for college with the help of the Montgomery G.I. Bill. In some career fields, the educational benefits can add up to $30,000.

What will you be doing?

In over 200 job specialties, the military's proven program of hands-on experience and classroom education gives you state-of-the-art career skills. It promotes leadership, confidence, and personal growth. It offers the educational and career opportunities you need to make the future you want.

So take one last look in the mirror, for old time's sake. Then go and see your local recruiter, or call **1-800-893-LEAD** for more information.

Catch a glimpse of yourself four years from now. You'll like what you see.

Make It Happen.

U.S. ARMED FORCES

ARMY ★ NAVY ★ AIR FORCE ★
MARINES ★ COAST GUARD ★

Copyrighted material

[LIKE MANY GREAT VEHICLES CHERISHED BY THEIR OWNERS, OURS IS DESTINED TO COLLECT DUST.]

Unlike most classic vehicles, the Sonoma Highrider wasn't meant to sit around in some millionaire's warehouse. It is, after all, a GMC Truck. So while it looks great in any parking space, Highrider is at its best in gear, whether it's cruising down the open highway or kicking up dust on the meanest dirt road. Just climb behind the wheel, and Highrider's appeal becomes immediately apparent. Its available 191 HP Enhanced 4.3 liter V6 is the most powerful engine in its class. And there are other niceties as well. Things like massive stabilizer bars. Huge 31-inch tires. Special heavy duty axles. And a suspension anchored by 46 mm Bilstein® shocks, built to absorb punishment. Even the frame was specifically designed for Highrider. It's a truck for truck fanatics, brought to you by the experts at GMC Truck. And although it has all the right qualities to inspire immense devotion in its owners, Highrider has one other distinct advantage: you won't be afraid to take it out of the garage. For more information, call 1-800-GMC-TRUCK.

GM Quality Network. Buckle up, America!

GMC TRUCK SONOMA ®THE STRENGTH OF EXPERIENCE

©1995 General Motors Corporation. All rights reserved. GM, GMC, GMC Truck, Sonoma, Highrider, and the GMC Truck logo are registered trademarks of General Motors Corporation.

Copyrighted material

SCIENCE & TECHNOLOGY

EDITED BY DAWN STOVER

MEDICINE

TOUCHY-FEELY ROBOT

Getting a physical exam can be uncomfortable, especially when the doctor pushes on parts of your anatomy in search of suspicious lumps. Now imagine being pawed by a robot whose ultra-sensitive "hand" conveys your body's contours to a physician at another location.

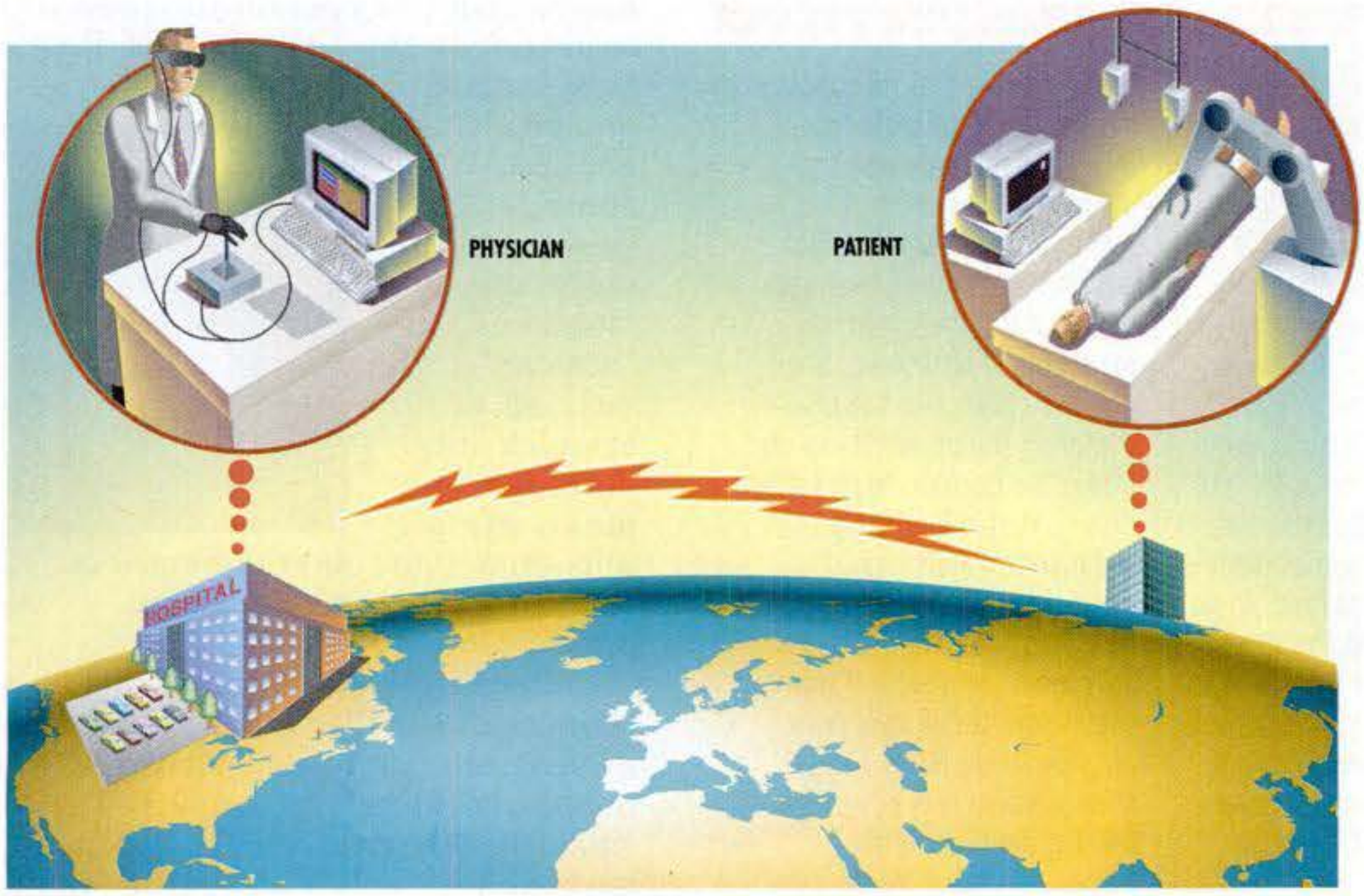
Welcome to the brave new doctor's office envisioned by engineer Michael Burrow of the Georgia Institute of Technology. Burrow and his colleagues at the Medical College of Georgia are developing a "teletactile hand" that will someday enable doctors to electronically reach out and touch sick someones in remote areas with few medical specialists.

The hand will be a tool of telemedicine, in which specialists use electronic links to examine patients who are miles away. Today, video and audio transmissions enable doctors to peer into the eyes, ears, and throats of patients from afar; analyze X rays and ultrasound exams performed elsewhere; listen to distant heartbeats; and conduct remote consultations. However, Burrow's teletactile hand would be the first device to enable faraway physicians to actually feel the bumps of buried tumors or inflamed organs. A related project at Georgia Tech uses tactile feedback to help students practice surgery [see "Robo Surgeons," April].

In Burrow's concept of how the teletactile hand will work, the doctor views the patient on a video monitor or virtual reality headset while using an electronic glove to direct the movements of the hand. As the hand touches the patient, tiny sensors detect the shape, texture, and firmness of the underlying tissue. That information is electronically sent back to the glove, where electrical and mechanical stimulators provide tactile feedback to the physician. For example, says Burrow, air-filled bladders in the glove might inflate like tiny balloons, "resisting the movement of a physician's fingers to provide a sense of hardness." A large, motorized joystick attached to the palm of the glove also resists hand movements to give the doctor a sense of how hard he is pressing.

Burrow is working on a simple prototype, which should be ready by the end of this year. He hopes to construct a complete system within five years. One challenge is keeping the equipment cost within reach of rural communities that can't afford medical specialists.

Someday, doctors might use the teletactile hand to perform surgery from afar, Burrow says. For that to happen, though, patients will have to trust a scalpel-wielding robot to do the right thing.—*Ingrid Wickelgren*



DALE GLASGOW & ASSOCIATES

Five years from now, a physician wearing a virtual reality headset and an electronic glove (left) may use a robotic hand to examine the body of a faraway patient.

Copyrighted material

SPACE

JUPITER OR BUST

A small probe will separate from the *Galileo* spacecraft this month, beginning a five-month journey to Jupiter. The mission marks the first attempt to penetrate the atmosphere of one of the solar system's outer planets.

Traveling solo for 50 million miles and reaching speeds of more than 106,000 mph, the four-foot-diameter craft will descend 400 miles into Jupiter's mysterious multicolored clouds. As it parachutes through the clouds, the probe will search for lightning, monitor winds, and document the constituents of the air before succumbing to the tremendous pressure of Jupiter's deep atmosphere.

The probe will relay information to Earth via the massive *Galileo* orbiter, launched in October 1989. The orbiter will pass 133,000 miles above Jupiter's clouds. "We're hoping for about 75 minutes" of scientific observations, says Marcie Smith, probe project manager at NASA's Ames Research Center. "That's about how long the orbiter can listen [before passing out of range]."

The probe will be spun to stabilize it, then launched this month from its cradle at the back of the orbiter. The orbiter will then change course to be in position for its voyage around Jupiter on December 7, when the probe enters the planet's atmosphere.

The probe recently passed a set of operational tests after years of hibernation in deep space. "We wanted to make sure the power system was in good shape," says Smith. By the time the probe powers up for its mission, the batteries will be six years old.

Following the probe's atmospheric mission, the *Galileo* orbiter is scheduled to study Jupiter's clouds, radiation fields, and moons for another two years.—*Michael Carroll*

JIM HERVAT

A parachute will slow the probe's descent through Jupiter's thick clouds.

THE OCEANS

LIFE AT THE BOTTOM

On March 24, the Japanese submersible *Kaiko* finally reached the deepest spot in the world's oceans, the 35,797-foot-deep Challenger Deep in the Mariana Trench southwest of Guam [see "Japan Challenges the Deep," May]. *Kaiko* is the first craft to visit the spot in 35 years.

As the world's only sub capable of diving below 21,000 feet, *Kaiko* is expected to play a key role in exploring ocean trenches. It has already settled the question of whether living things can survive the eight-ton-per-square-inch pressures at the bottom of the Challenger Deep, by bringing back photos and video footage of marine worms and a crustacean.

The depth *Kaiko* attained is about three feet short of the record set by the U.S. bathyscaphe *Trieste* in 1960. But recent ultrasound measurements indicate that *Kaiko* landed in the deepest part of the trench, suggesting that previous measurements were limited by the accuracy of vintage equipment.—*Dennis Normile*

GENETIC ENGINEERING

AN EYE FOR A FLY

It sounds like a warlock's recipe. Take a certain gene. Insert it—anywhere—into a fruit-fly embryo. Presto: a large, perfectly formed fly eye. But it's science, not witchcraft.

Using what they call the "master control gene" for eye growth, Swiss researchers at the University of Basel have made extra fly eyes appear on antennae, wings, and feet. While some 2,500 genes contribute to eye development, the "master" directs all of the complex interactions that make simple cells grow into fully formed eyes.

W.J. GEHRING

An extra eye grew on this fly's antenna.

Called "eyeless" (because its absence results in flies with no eyes), the gene is similar to one identified in mammals, including humans. These similarities suggest that the eye may have evolved only once, rather than separately in a variety of species. —*Mariette DiChristina*

ENVIRONMENT

ARSENIC AND OLD LAKES

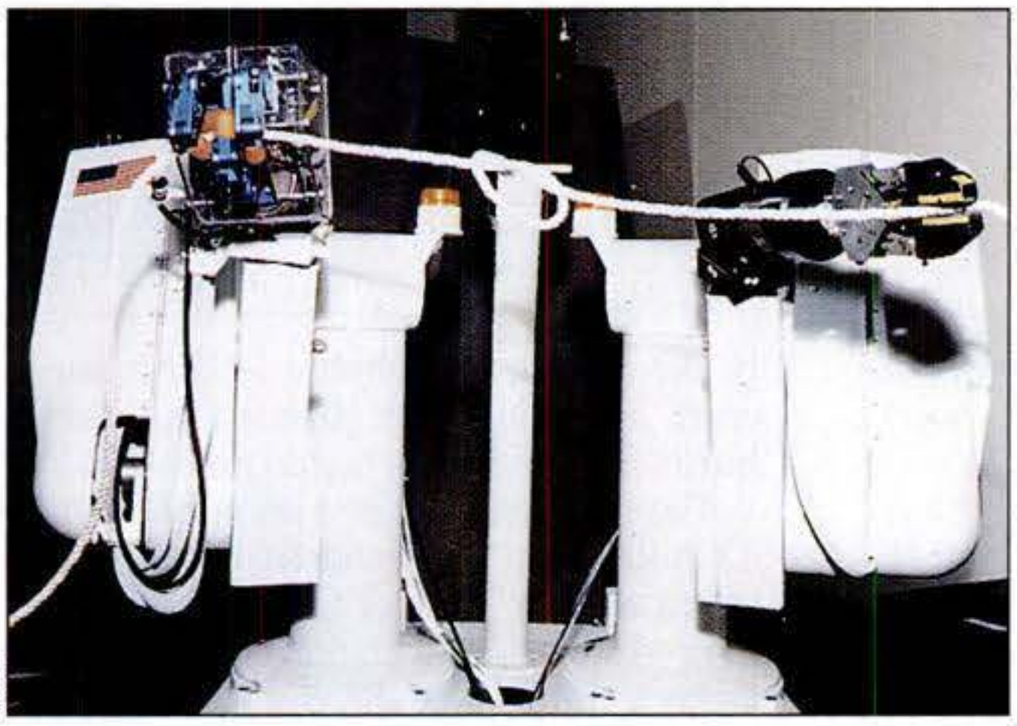
For nearly a decade, MIT scientists had been puzzled by the abnormally high concentrations of arsenic they found dissolved in lakes and streams in eastern Massachusetts. The poison was dumped into the water by chemical companies during the mid-1800s to 1930s. Given the many years that had elapsed, scientists assumed that most of the arsenic would have long since attached itself to sediments on the lake bottoms and river beds. Since this was not the case, the researchers wondered whether some biological agent might be responsible for the unusually high levels of dissolved arsenic.

After extensive laboratory studies, the culprit was identified: a previously unknown bacterium dubbed MIT-13. This muck-dwelling microorganism doesn't actually "eat" arsenic, but it does use the particle-bound form of arsenic to break down its food. In so doing, it converts the arsenic to its more toxic soluble form.

"This is the first microorganism known to derive energy from arsenic," says Dianne Ahmann, an MIT biologist heading the research team. While a few other microbes are known to tolerate arsenic, MIT-13 is the only one that actually thrives on it.

Ahmann is now investigating how the bacteria manage to withstand the extremely toxic effects of arsenic. She and her colleagues are also exploring the possibility of enlisting the bacteria to dissolve arsenic that is locked up in sediments. Filters placed downstream in a river might then trap the toxin by chemical means, removing it from circulation. If this idea pans out, the lowly MIT-13 may soon become one of our great unsung environmental heroes.—*Steve Nadis*

Copyrighted material



NASA

Controlled by a human operator wearing virtual reality gear (top), a robot mimics complex activities such as knot tying.

ROBOTICS

BODY DOUBLE

Engineers at NASA's Johnson Space Center in Houston are developing a robotic slave that mimics the movements of its human master. Gone are the joystick controls inherited from aircraft designers. "The beauty of this is that you can operate the robot the way you operate your own body," says project engineer Larry Li.

The robotic system has two components: a humanlike robot with stereo vision, and a set of virtual reality equipment worn by the operator who controls the robot. With its six-jointed arms and nine-jointed hands, the robot is deft enough to grasp a wing nut or tie a knot. Twin video cameras and a laser rangefinder mounted on its neck help the operator locate objects, and a camera mounted on the hand provides closeup views.

In space, the robot could be used for repairs and servicing, or for planetary exploration. On Earth, it has applications in firefighting, search and rescue, ammunition disposal, and undersea exploration. A miniaturized version could even be used for microsurgery.

Li's team is working on artificial intelligence and force-feedback systems for the robot. The engineers are also developing a speech system that will cue the robot to perform a series of actions upon a simple verbal command, such as "find screwdriver." Eventually, says Li, "we imagine an intelligent dialogue between the human and the robot."

AVIATION

WIND SHEAR SENSOR FOR COCKPITS

A new breed of cockpit radars could help prevent airplane accidents caused by wind shear—a phenomenon that is associated with thunderstorms and can produce sudden, fierce downdrafts.

The sensors currently installed in commercial jetliners notify pilots of wind shear *after* the plane encounters it, when it may be too late. Last July, for example, a USAir jet equipped with such a "reactive" sensor slammed into the ground when it encountered violent wind shear near Charlotte, N.C., killing 37 people. Meteorologists say that even if the wind sensor had gone off (it didn't because of an unrelated design flaw), it would not have done so in time to prevent the catastrophe.

The new "predictive" sensors will alert pilots 15 to 60 seconds *before* their aircraft encounters wind shear, giving them enough time to climb above the dangerous weather. The sensors rely on Doppler radar, developed at NASA's Langley Research Center, to search the airspace ahead of the plane for regions where the airspeed varies greatly across a short distance. When the radar finds such a region, an onboard computer checks for "false alarms" caused by moving objects on the ground or momentary turbulence. If the wind shear readings persist, and the jet is within 1.5 nautical miles of the bad weather, the computer issues an audible warning.

Continental Airlines plans to retrofit its entire jet fleet with predictive sensors from Allied Signal by late 1996. Other airlines will install the sensors on new planes.—*Robert Langreth*

MATERIALS

CHARGING AHEAD

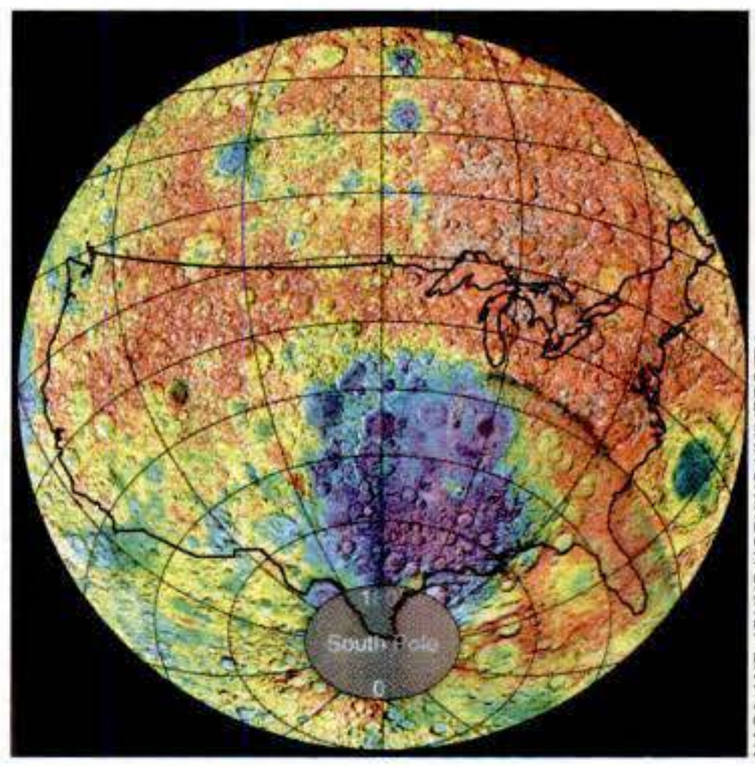
Superconductors could someday make it possible to transmit electricity along power lines with virtually no resistance, saving enormous amounts of energy. Taking a big step toward that goal, researchers at Los Alamos National Laboratory have invented a superconducting tape with a current-carrying capacity nearly 100 times greater than previous superconductors.

The researchers created the tape by depositing a thin layer of superconducting ceramic on a nickel tape coated with cubic zirconia. Unlike other superconductors, the tape is flexible. It loses its resistance to electricity when cooled by liquid nitrogen.

THE MOON

OFF CENTER

Images of a massive crater, sent back to Earth during a recent lunar mapping mission, have helped scientists explain why the moon's center of gravity is slightly displaced. Scientists believe the crater was created some four billion years ago, when a 125-mile-wide object struck a glancing blow.



NASA AND JOHNS HOPKINS UNIVERSITY

The South Pole-Aitken Crater is the largest and deepest in the solar system.

The impact displaced a large section of lunar crust, creating a 7.5-mile-tall highlands zone (shown in orange) north of the crash site, and shifting the moon's center of gravity.

The crater (shown in purple and blue) is 7.5 miles deep and 1,550 miles wide. Hidden on the dark side of the moon, it has been christened the South Pole-Aitken Crater, because it is located near the south pole and contains a smaller crater called Aitken.—*Sandy Fritz*

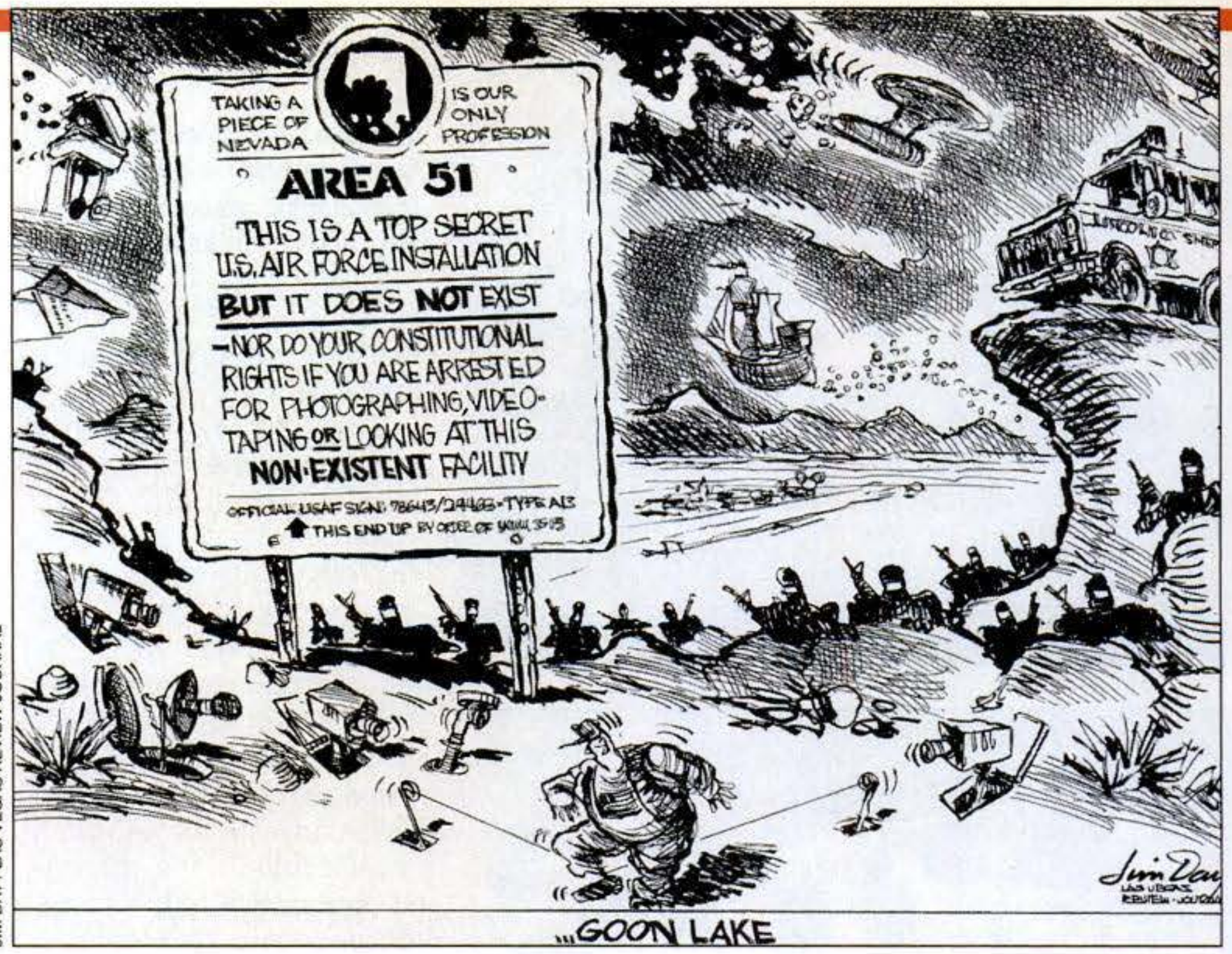
Copyrighted material

MILITARY TECH

OFF LIMITS: GROOM LAKE

A notice published in the *Federal Register* in April signaled an end to easy viewing of the classified Groom Lake air base 90 miles northwest of Las Vegas [see "Searching for the Secrets of Groom Lake," Mar. '94]. The Air Force has extended the security perimeter of its giant Nellis Range complex, swallowing up approximately 4,000 acres of federal land formerly open to the public. The closed area includes Whitesides Mountain and Freedom Ridge, vantage points that were frequented by secret-airplane buffs and UFO seekers.

After two lawsuits were filed last August, alleging that workers at the secret facility had been injured by fumes from illegally burned toxic wastes, the Air Force obliquely acknowledged that the Groom Lake base known as Area 51 or Dreamland does indeed exist. Last year, an official statement referred to an unnamed "operating location near Groom dry lake."


TAKING A PIECE OF NEVADA
IS OUR ONLY PROFESSION
AREA 51
THIS IS A TOP SECRET U.S. AIR FORCE INSTALLATION
BUT IT DOES NOT EXIST
-NOR DO YOUR CONSTITUTIONAL RIGHTS IF YOU ARE ARRESTED FOR PHOTOGRAPHING, VIDEO-TAPING OR LOOKING AT THIS NON-EXISTENT FACILITY
OFFICIAL USAF SIGN: 78643/24465-TYPE A13
THIS END UP BY ORDER OF YOUR 3575
"GOON LAKE"
JIM DAY / LAS VEGAS REVIEW-JOURNAL

The official name is important to professor Jonathan Turley of George Washington University's National Law Center, attorney for the Groom Lake workers who filed the suits. Turley is seeking to force disclosure of the base's name, a technicality required for the suits to proceed. Federal officials are also investigating hazardous waste violations at the busy complex where secretly developed spy planes, stealth aircraft, and captured Russian military hardware have been tested since 1954.

Tikaboo Peak, located on public land 13 miles east of Freedom Ridge, still offers a clear view of Groom Lake for dogged watchers who don't mind being twice as far away.—*Stuart F. Brown*

"DORAL GUARANTEES PREMIUM TASTE"

SEE PACK FOR DETAILS

SURGEON GENERAL'S WARNING: Smoking By Pregnant Women May Result in Fetal Injury, Premature Birth, And Low Birth Weight.

LIGHTS: 8 mg. "tar", 0.6 mg. nicotine, FULL FLAVOR, FULL FLAVOR MENTHOL: 14 mg. "tar", 0.9 mg. nicotine, av. per cigarette by FTC method.

Copyrighted material

PLANTS

FOREST OVERACHIEVERS

While the jury is still out on whether electromagnetic fields are harmful to humans, recent evidence suggests that these fields can stimulate plant growth.

Researchers monitoring the forest around a 55-mile-long Navy communications antenna in Michigan's Upper Peninsula found that red pines near the antenna grow taller than red pines in other parts of the forest. The researchers, led by David Reed of Michigan Technological University, also discovered that the trunks of aspen and red maple trees near the antenna are thicker than expected.

"It surprised us," says Reed. Two other tree species, as well as smaller plants near the antenna, failed to show increased growth rates. Reed speculates that the electromagnetic fields around the antenna may affect the speed at which some plants process and transport nutrients. "But we just don't know," he says.—*S.F.*

HERMAN MULLER

The 185-foot wingspan of Grob's high-altitude research aircraft (right) dwarfs that of a pleasure plane.

AVIATION

HIGH FLYER

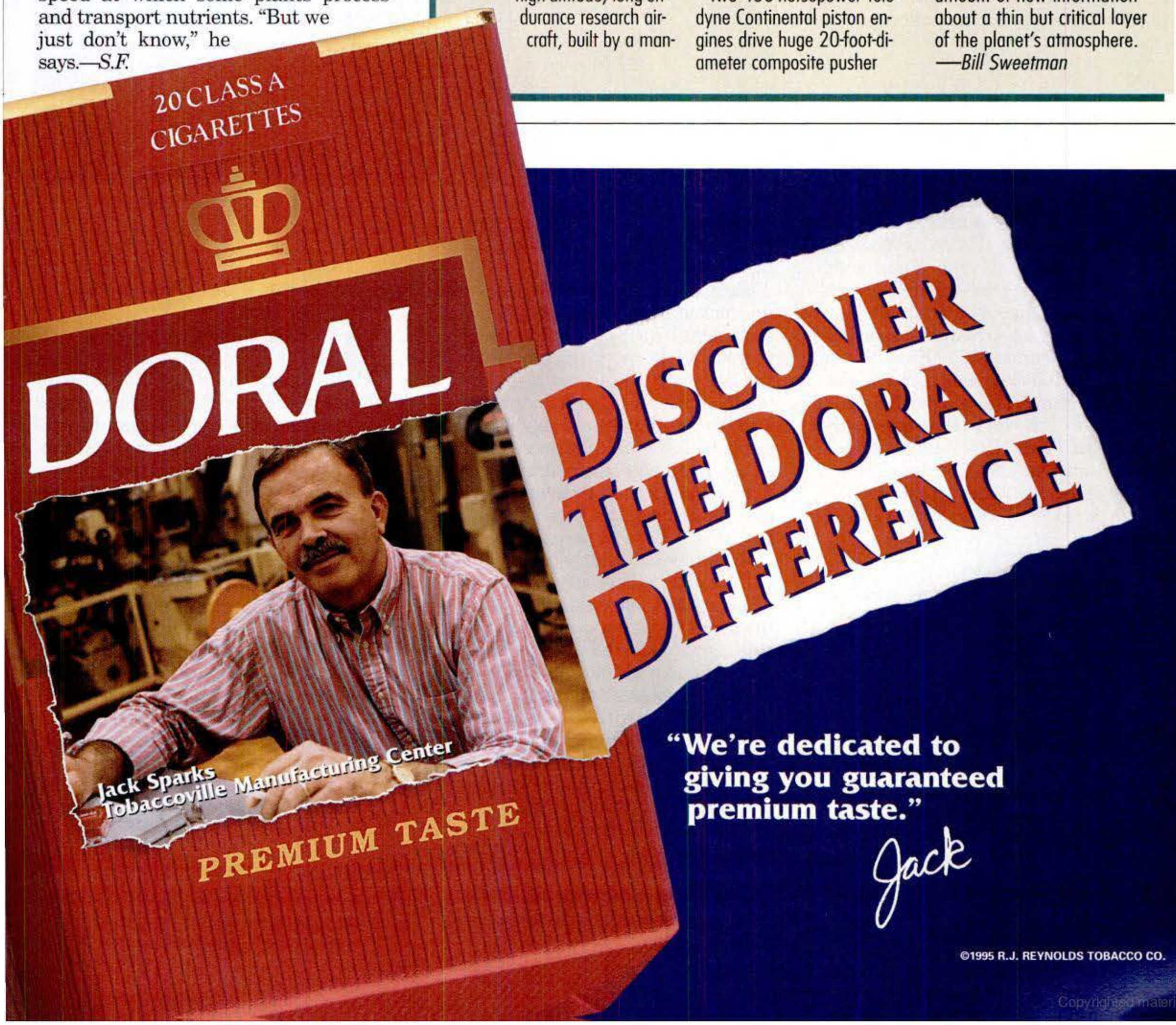
Is the ozone layer disappearing? It might be easier for scientists to answer this question if they could pay a visit. But most ozone resides in the stratosphere. The few aircraft capable of flying there, including the Concorde and the U-2 spy plane, are too costly for most research budgets.

That's why the German government is funding a new high-altitude, long-endurance research aircraft, built by a manufacturer of light aircraft and high-performance gliders. Now being prepared for its first flight, the Grob Strato 2C is designed to reach a maximum altitude of 82,000 feet—as high as a U-2—carrying two pilots, two observers, and a cargo of scientific equipment.

The Strato 2C is built almost entirely from composite materials. Its slender wing spans 185 feet, the same as a B-52 bomber. The cabin is pressurized, so crew members don't have to wear cumbersome suits as U-2 pilots do.

Two 450-horsepower Teledyne Continental piston engines drive huge 20-foot-diameter composite pusher propellers. Each engine has an elaborate three-stage turbocharger, based on the compressor and turbine sections of a PW127 turboprop engine, to maintain full power at high altitude.

The engines are miserly fuel users: The Strato 2C is designed to cruise at 79,000 feet for eight hours during a 17-hour flight. At 59,000 feet in the lower stratosphere, the Strato 2C can stay aloft for 48 hours, covering more than 11,000 miles and gathering a vast amount of new information about a thin but critical layer of the planet's atmosphere.
—*Bill Sweetman*



Copyrighted material

SCIENCE & TECHNOLOGY

THE HUMAN BODY

SIZING IT UP

Many women have trouble finding clothes that fit properly, because the current sizing system is based on studies of 1940s-era body types. "It is assumed that the taller you are, the wider you are," says Susan Ashdown, an assistant professor of textiles and apparel at Cornell University. But changes in diet, ethnic diversity, and other factors have produced a wide range of body proportions among American women today.

Using women's measurements from the U.S. Army, Ashdown and a colleague are developing a statistical model that groups individuals with similar measurements into size clusters. An apparel manufacturer can select the type of garment and the number of sizes to be made, and the model will compute a set of sizes that fit most American women. The Army plans to use the system to design uniforms.

SPORTS TECHNOLOGY

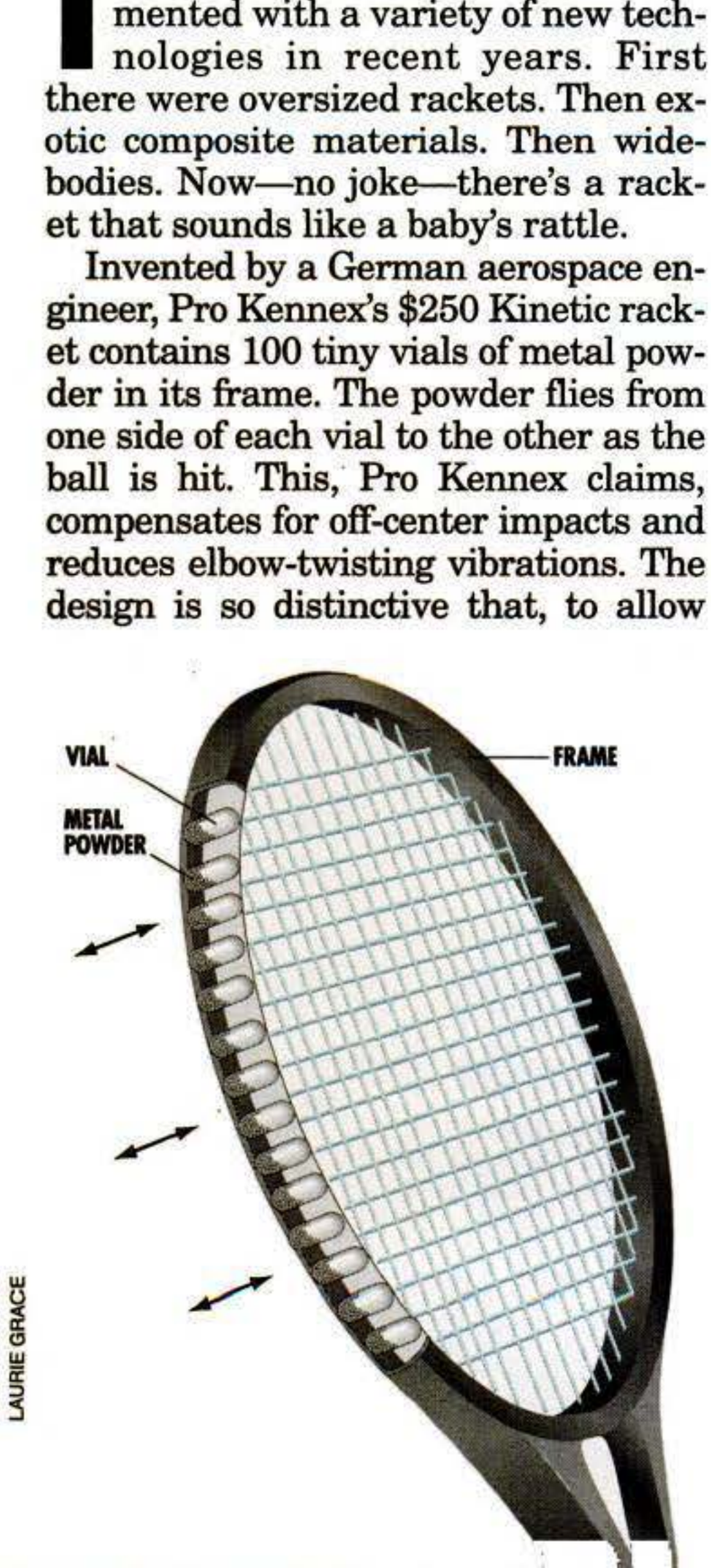
RATTLE RACKET

Tennis racket makers have experimented with a variety of new technologies in recent years. First there were oversized rackets. Then exotic composite materials. Then widebodies. Now—no joke—there's a racket that sounds like a baby's rattle.

Invented by a German aerospace engineer, Pro Kennex's $250 Kinetic racket contains 100 tiny vials of metal powder in its frame. The powder flies from one side of each vial to the other as the ball is hit. This, Pro Kennex claims, compensates for off-center impacts and reduces elbow-twisting vibrations. The design is so distinctive that, to allow the Kinetic racket into competition, the International Tennis Federation has had to alter its rules.

Skeptical? So were we. When one editor picked it up, he thought sand had gotten into the frame. But when we played with it, we practically had to hit the ball with the frame to produce a terrible shot. And as for vibrations—well, we hardly noticed any. Lab tests conducted at MIT confirm our impressions: Engineers there found the Kinetic racket has 48 percent less vibration than normal rackets, and a sweet spot that is 12 to 15 percent larger.

How does it work? When the tennis ball hits the racket strings, the metal powder inside the vials accelerates in the direction of the swing. As momentum is transferred to the ball, the racket head itself slows down. But the powder continues moving forward until it collides with the ends of the vials. The extra mass moving in the direction of the swing helps reduce the twisting normally produced by an off-center hit. After the ball has left the frame, the extra mass also damps vibrations.—*R.L.*



LAURIE GRACE

When this tennis racket makes contact with a ball, metal powder shifts inside the frame to absorb vibrations.

NATURE

WALKING ON WATER

The basilisk lizard of Central America is capable of a feat that turns biologists into believers—walking on water. Actually, the lizard runs across the water in a mad, almost comical dash, with its rear legs windmilling around its ears about 20 times per second.

Biologists first discovered this "Jesus lizard" years ago, but until recently they didn't know how it stays above the water. According to Jim Glasheen, a doctoral candidate at Harvard who studies the lizard, the answer lies in its feet. The moment they hit the water, an extra row of scales on the side of each toe is forced outward, increasing the foot's surface area. This allows the foot to generate almost enough force on impact to support the lizard's weight. As the foot pushes down into the water, it creates an air bubble that provides additional support, allowing time for the other foot to wing around and hit the water. With the weight supported on the second foot, the lizard can pull the first one back up to the surface before the air bubble collapses. The bubble is crucial, because if the lizard had to pull its foot back up through water instead of air, the resulting drag would turn the runner into a swimmer.

Using the same strategy as the lizard, could humans sprint across a watery expanse? Yes, says Tom McMahon, a Harvard professor who advised Glasheen on the project. But since you would need to take 269 steps per second, don't try it without putting on your wet suit.
—*Jerry Shine*

STEPHEN DALTON / NHPA

A basilisk lizard dashes for shore.

MEDICINE

RELIEF FOR DRY EYES

About 12 million Americans cannot produce enough tears to lubricate their eyes. Some of these people have to apply eye drops as often as 200 times a day to prevent dry eyes from stinging, itching, and developing infections.

For patients who need drops frequently, Dr. Vo Toi Van of Tufts University has invented a device that delivers the drops automatically. The device is a small box, worn in a pocket or on a belt, that contains a battery-powered pump and a fluid reservoir. When the pump is activated, fluid is forced through a narrow tube attached to a pair of eyeglasses. At the end of the tube are nozzles that eject drops into the inner corners of the eyes.

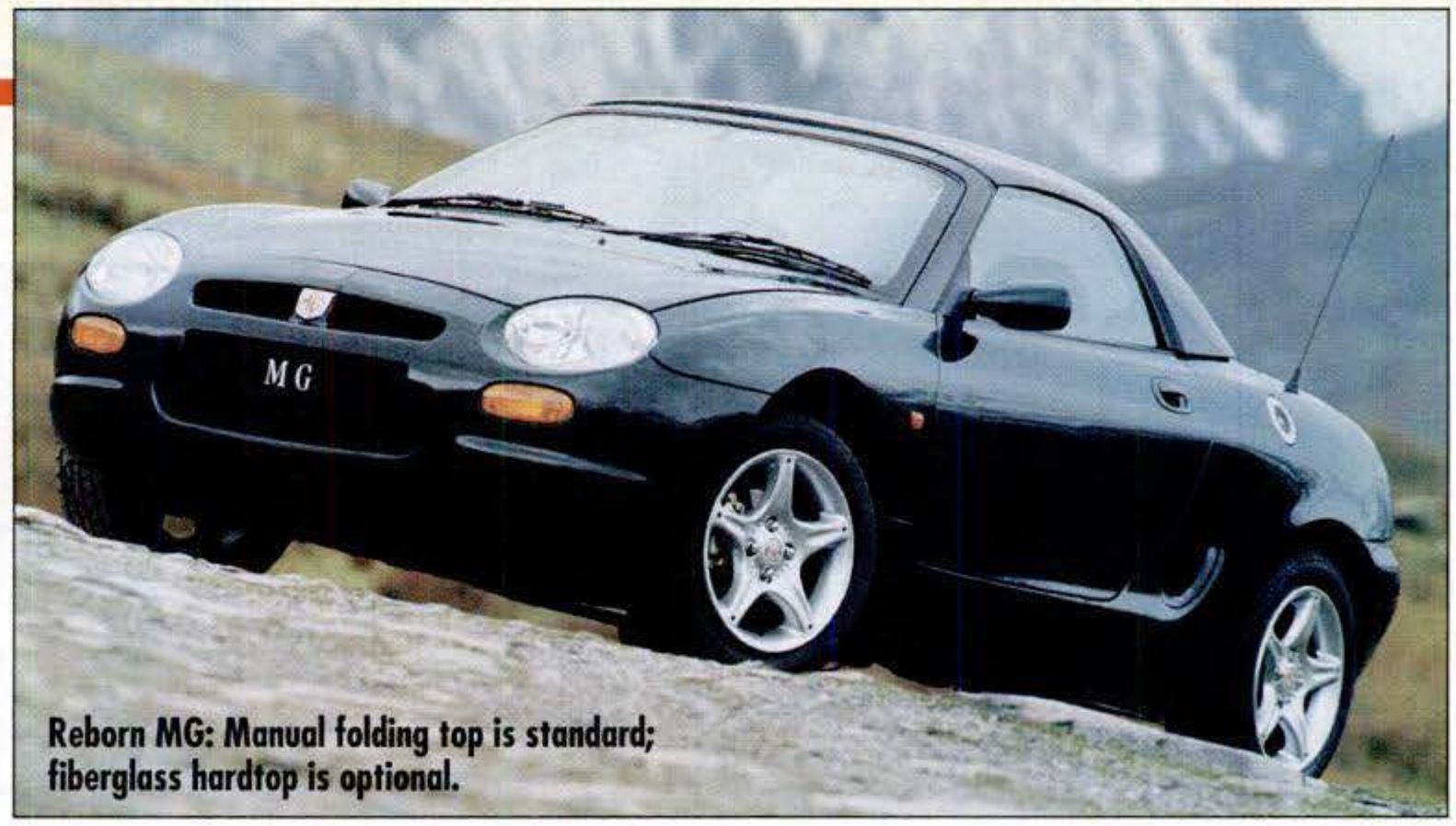
A computer chip in the box programs the pump to eject drops at preset intervals. The wearer can also press a button on the box for an instant squirt.

The device can be adapted to fit a wide range of metal or plastic eyeglass frames.—*Herbert Lass* PS

Copyrighted material

AUTOMOTIVE

EDITED BY DAN McCOSH



Reborn MG: Manual folding top is standard; fiberglass hardtop is optional.

NEW MODELS

MG REVIVED

Rover's MGF revives a motoring legend born 70 years ago with the first MG, a sports car for drivers who craved the wind in their hair, the aromatic blend of engine oil and exhaust fumes, and a jiggly ride on low-slung seats. The new model, long awaited since 1980 when the last MG was built, is a mid-engined two-seater loaded with advanced technology.

This power layout with driven rear wheels provides optimum balance and road grip, Rover says, with weight transfer to the back wheels under acceleration. It also avoids the "torque-steer" problem common with front-wheel drive. Transversely mounted behind the cockpit, the base engine is a 1.8-liter twin-cam 16-valve four-cylinder developing 120 horsepower at 5,500 rpm. It gives a zero to 60 mph time of 8.5 seconds, and a top speed of 120 mph. But with a clever cylinder head concept called the 1.8 VVC (Variable Valve Control), the engine gets a power boost to 145 hp at 7,500 rpm, and that critical acceleration time is cut to just seven seconds. While Honda, Alfa Romeo, and others already offer variable valve timing, the Rover system is unique in allowing infinitely variable camshaft angles where the inlet valves open and close.

Speed-sensitive electric steering not only eliminates the power drain and noise of the conventional engine-driven hydraulic pump but also optimizes the assistance needed for different driving conditions. The level of steering effort required is measured by a torque sensor in the steering column, then passed to an electronic control unit that calculates the ideal amount of power assistance required. The ECU controls an electric motor on the column that reduces steering effort. Prices range from $25,000 for the 1.8i model to $28,000 for the fully equipped VVC version.—*David Scott*

ELECTRIC VEHICLES

BATTERIES VERSUS DIESELS

Germany's Deutsche Bundespost Postdienst—aka the post office—is experimenting with zinc-air battery electric powertrains in place of the diesel engines normally used in its mail vans. If the cost of operating electric trucks turns out to be lower, the Postdienst will switch from diesel power.

A test fleet of 60 vehicles is being converted to electric drive. Included are 15 Mercedes-Benz 4.5-ton vans equipped with 1,670-pound, high-energy-density battery packs that offer a driving range of about 200 miles. Electric Fuel Corp. of Israel supplies the batteries and special machinery used to refuel them.

Electric Fuel's system consists of battery modules with removable zinc-anode cassettes that can be exchanged for freshly charged anodes using a special machine located at the fleet garage. Refueling a van takes ten minutes, the company says. The depleted anode cassettes are then recycled and recharged. In the process, any undischarged zinc is removed from the plates and reused. Discharged zinc oxide dissolved in electrolyte is sent through a process that forms charged zinc particles that are then made into new anode cassettes.

An encouraging preliminary assessment of Electric Fuel's system led the Postdienst to launch an 18-month field test beginning this year. Fuel costs for the diesel vans in Germany, where energy is expensive, are about ten cents per mile. Zinc-air electric refueling is expected to cost about six cents per mile, using off-peak electricity.

If test results are positive, the Postdienst intends to equip half of its 50,000 vehicles with electric drive using Electric Fuel's zinc-air battery refueling system.—*Stuart F. Brown*

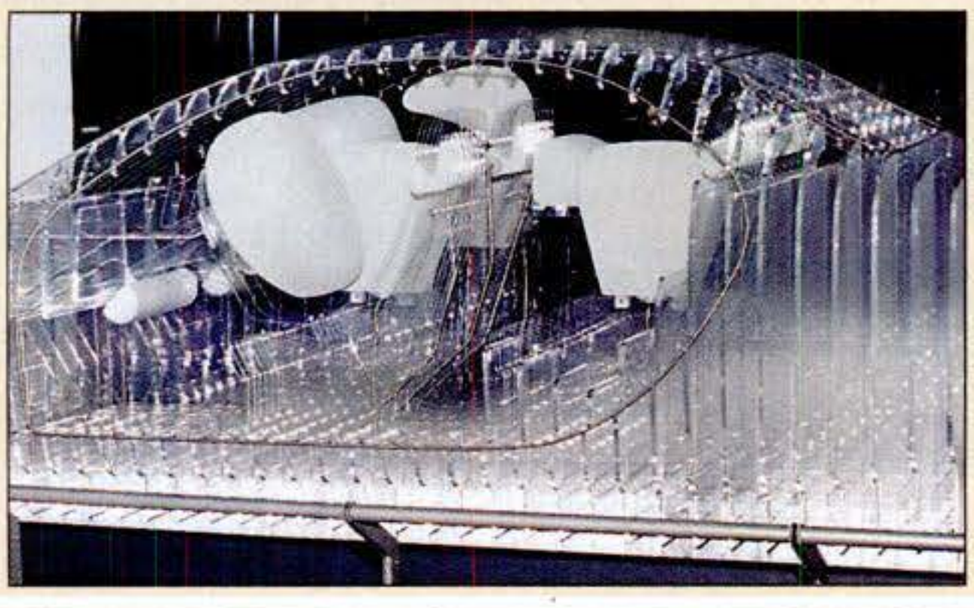
SAFETY

AIRBAGS R US

Mercedes-Benz, the first automaker with a production airbag, is now taking the lead in airbag research with an experimental car that has no fewer than seven different airbag systems and a total of 17 airbags. Not intended to deploy simultaneously, the multi-airbag system could eventually be tied into an advanced crash detector that inflates the appropriate system at the appropriate time. The airbags include:

- Asymmetrical driver and front-passenger airbags, designed to protect occupants in offset front-end collisions.
- Knee bags, to protect the pelvis and leg area.
- Side bags, located inside door panels.
- A center bag, to separate the driver and passenger.
- Roof bags, deployed in rollover accidents.
- Head-restraint bags, activated in rear impacts.
- Rear airbags, including side, center, and between-passenger bags.

If all this seems far-fetched, there is a near-term first step: Mercedes will offer side-impact bags on a 1996 model and will soon have a device to detect the position and size of the car's occupants.



Seven airbag systems in this experimental car would inflate depending on where the car was struck in an accident.

Copyrighted material

SAFETY

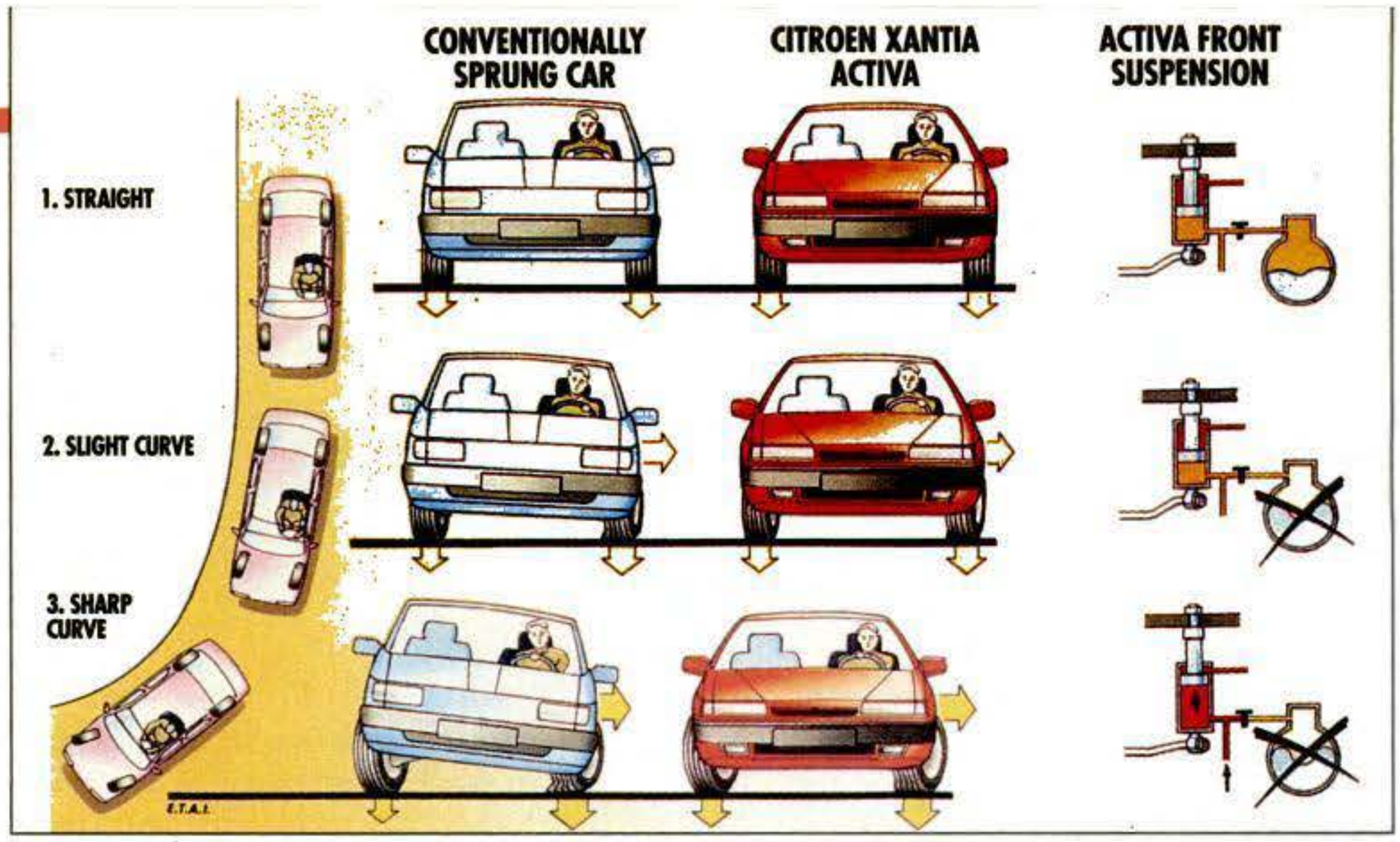
BLACK BOX FOR CARS

Now there's an Accident Data Recorder for cars, comparable to an airplane's "black box" flight recorder. It determines the probable cause of the accident and produces a printed record of events that could help with a damage claim, avoid a loaded insurance premium, or even serve as legal evidence in court.

Made in Germany by Mannesmann Kienzle, the device is about the size of a car radio and costs about $450 plus installation. Thousands are already in use in Europe.

The unit records data from three dynamic sensors and ten status inputs in a solid-state memory. This provides a continuous short-term register of car movements and driver controls, which is overwritten every 45 seconds. The sensors monitor the car's longitudinal and lateral acceleration, together with its rotation when cornering or swerving. Status inputs are for electrical functions like the ignition switch, brake lights, turn indicators, and high/low headlight beam, plus road speed, clock time, and date.

If an impact is detected, the last 30 seconds of memory are frozen, while recording continues for another 15 seconds. The data can be read with special software by accident investigators, who make a printout showing all factors that set the scene of the accident and may have contributed to it. The fee in Germany for such accident reconstruction is $125.—*D. S.*



Taking the roll out: 1. Cushioning of gas spring halves roll bar stiffness for comfort in straight driving. 2. Solenoid valve isolates gas spring for body leveling with full force of roll bar in slight curves. 3. Added hydraulic cylinders counter centrifugal force by jacking up outer side of car in sharp curves.

SUSPENSIONS

ROLL-FREE CORNERING

Citroen's new Xantia Activa has roll control that matches and possibly betters the Lexus system. Both systems eliminate body roll when cornering, for greater comfort and improved handling. Lexus uses a special air suspension as a premium alternative to the car's standard coil springs.

The standard Xantia has Citroen's established Hydractive suspension, where the spring medium is nitrogen gas contained in a sphere and separated by a flexible membrane from pressurized hydraulic fluid.

With a few extra suspension parts, the Xantia Activa provides active antiroll suspension. This keeps the body horizontal in a curve. An added gas sphere and hydraulic cylinder fitted to each axle are linked to beefed-up antiroll bars. For straight-line driving, the gas spheres halve the bar's increased stiffness, maintaining ride comfort.

In the first cornering stage, these cushioning spheres are isolated by solenoid valves, thereby engaging the full roll-corrective action of the hefty bars. As increasing cornering force swings the body past a measured half-degree (0.5-degree) tilt, high-pressure fluid is directed to the two added hydraulic cylinders. These are instantly pumped up against the front and rear suspension to level the body.

By contrast, the Lexus' active roll control stiffens its air springs with increased pressure in a bend. Citroen's hydraulics could give it an edge on leveling action, because fluid provides a positive and precise force against the compressibility of air.—*D. S.*

PREVIEW DRIVE

FROM HERE TO INFINITI

The new Infiniti I-30 adds a fourth model to the Infiniti lineup. Its 106.3-inch wheelbase and a price tag in the low $30,000 range puts it somewhere between the G20 sports sedan and the J30. The I-30 is based on the Nissan Maxima platform, a heritage that produces an ingratiating, low-key sports sedan that combines one of the most refined V6 engines available today with a well-tuned chassis.

The all-aluminum, three-liter DOHC V6 produces 190 horsepower at 205 foot-pounds of torque with free-revving, silky refinement. The split manifold flattens the torque curve, giving the I-30 good performance in slow traffic and climbing hills. Although the engine is not exactly a stump-puller, it's one of the smoothest V6s in existence. Hydraulic engine mounts, electronically controlled on some models, mask whatever vibration attempts to reach the occupants.

The rear suspension is a new variation on the twist-beam solid-rear-axle popularized by Audi and found in many Chrysler products. The transverse solid-axle design is noted for accurate control of rear camber, holding the wheels at a constant angle to the road. The I-30 adds a tricky secondary link to the beam that also inhibits jacking and other quirks inherent in this design. The result is a solid combination of limited body roll, little ride harshness, and a confident highway ride. The handling is marred by the engine-speed-sensing power steering that can be vague at lower speeds in city driving.

The I-30 shares most of the character of the equally smooth-running Maxima, adding only a few mechanical features, like the limited-slip option, one of very few offered on front-drive cars.

Copyrighted material

ALL-NEW AQUATRED II.

New Aquatred II.

- *Deeper, wider AquaChannel sweeps water away for superb wet traction.*
- *All-season tread with a new 65,000-mile limited treadlife warranty. See dealer for details.*
- *Advanced tread pitch design for reduced road noise.*

IT HAS A DEEPER, WIDER AQUACHANNEL.™

Goodyear introduces the next generation all-season radial for superb wet traction. The all-new Aquatred II.® It has a bolder, wider, deeper AquaChannel™ to sweep even more water away than our original Aquatred. For outstanding traction in the rain.

AND A NEW 65,000-MILE TREADLIFE WARRANTY.

A new, more durable compound adds treadlife. And value. With a 65,000-mile warranty. The all-new Aquatred II.

New AquaChannel. New warranty. **Only from Goodyear.**

THE BEST TIRES IN THE WORLD HAVE GOODYEAR WRITTEN ALL OVER THEM.

Copyrighted material

EMISSIONS

GASOLINE-ELECTRIC VOLVO

Volvo isn't wasting any time charting its strategy for the EPA-mandated era of ever-cleaner cars. It knows these cars are just around the corner. By 1998, the company plans to sell a hybrid gasoline-electric powered variant of its 850 model in California. The car is expected to consume 20 to 30 percent less gasoline than the conventional version in city driving. It will also cost about 30 percent more than the gasoline-powered car, bringing the price tag to about $35,000.

Engineers in Sweden are currently experimenting with an 850 test vehicle equipped with a battery-electric powertrain. The development "mule" tows a trailer containing a four-cylinder 50-horsepower gasoline engine powering an alternator. The driving range on pure battery power is about 68 miles at 25 mph, and 41 miles at 50 mph, according to Volvo. The range using the gasoline generator is limited only by the capacity of the fuel tank.

Small three- or four-cylinder gasoline engines are being considered for the production hybrid car. The piston powerplant will run at a nearly constant speed to optimize fuel efficiency and exhaust emissions. Running in a combined hybrid mode using both battery and gasoline-alternator power, the car's 100-hp electric motor will permit cross-country driving in mountainous terrain. Running only on batteries, it will meet California's zero-emission-vehicle standards.

Under California regulations, smaller automakers like Volvo aren't required to sell ZEVs until 2003. However, as a maker of large cars that are likely to perform poorly on batteries-only power, Volvo is anxious to show that its vehicles can be significantly cleaner and more efficient without losing their traditional appeal. Developing a hybrid for sale to consumers just three model years from now is a bold move, and one that could even affect government policy.

Volvo is no stranger to advanced propulsion design, having tapped its Flygmotor jet-engine division for the turbine and high-speed generator technology featured in its earlier Environmental Concept Car [see Automotive Newsfront, Jan. '94]. Though this exotic aerospace technology is too expensive to make it into first-generation hybrids, it shows where the minds of engineers drift when ultra-low exhaust emissions move to the front burner.—*S. F. B.*

PREVIEW DRIVE

ACURA TL SERIES: LUXURY TOURING

For those who prefer action to talk and a demure appearance to racy lines, the new Acura TL series really delivers. The Acura 2.5 TL borrows the 176-horsepower, all-aluminum five-cylinder engine from the discontinued Vigor, along with the Vigor's sport-tuned double-wishbone suspension. With four-wheel disc brakes and low-profile all-season tires shod to 15-inch aluminum alloy rims, the 2.5 TL quickly became a favorite on the handling track at Honda's R&D center in Tochigi Japan.

The 3.2 TL, with the 200-hp V6 lifted from the Legend, is tuned for a luxury ride. Its double-wishbone suspension includes electronic dampeners at the head and base of the shock absorbers to modulate road shock. The 3.2 TL's progressive power steering is a tad lighter than that in the 2.5 TL, although both cars display excellent on-center feel and respectable road feel. Like the 2.5 TL, the 3.2 TL includes four-wheel disc brakes and ABS.

Bodies and interior space for both four-door cars are nearly identical; in fact, the interior and exterior dimensions for the TL series are very close to the original Acura Legend. Acura has not set prices yet, but hints at a $29,000 price for the 2.5 TL ranging up to about $35,000 for the 3.2 TL.

Acura, by the way, is introducing all its new models with alphanumeric designations; the number before the letters designates the engine's displacement in liters, while TL stands for Touring Luxury.—*Sandy Fritz*

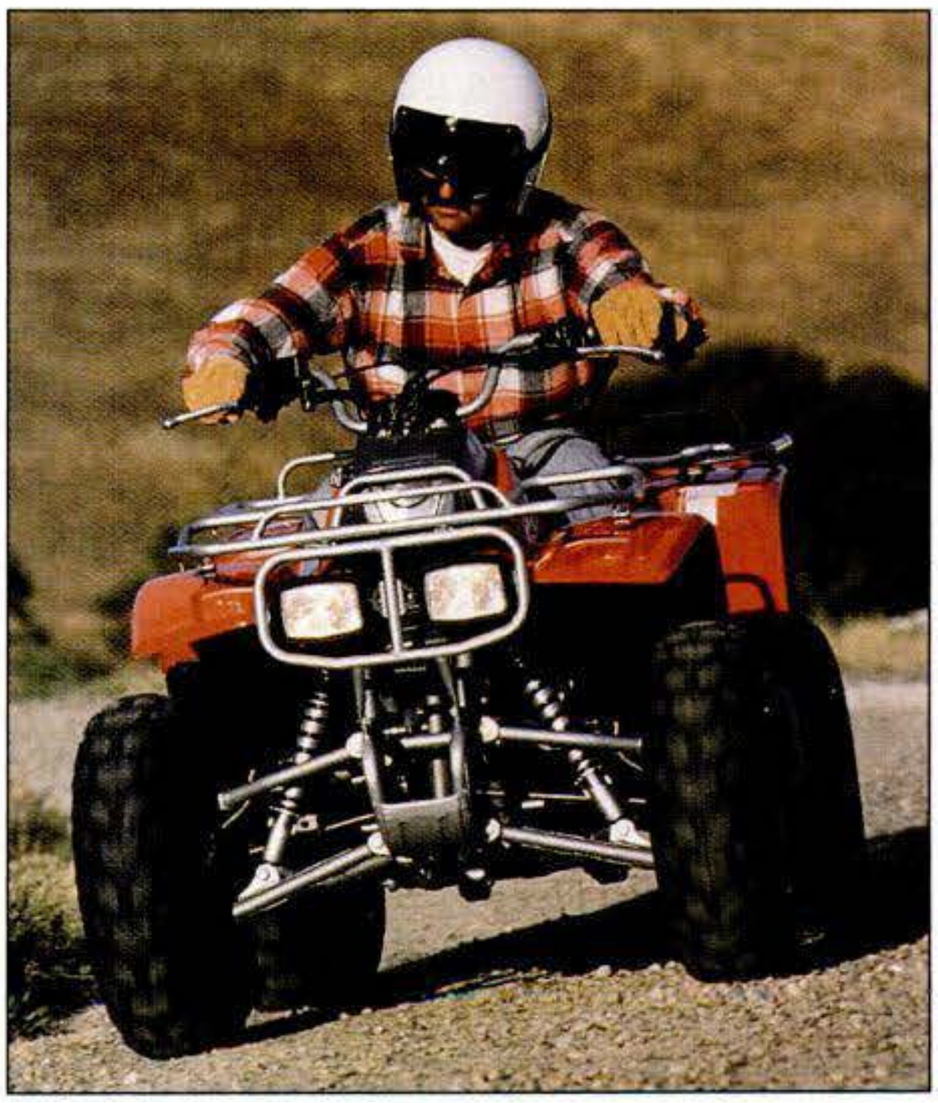
ATVS

FUN & FUNCTIONAL

When you're romping full-throttle though a muddy riverbed, it's not easy to take seriously Kawasaki's claim that the new Lakota all-terrain vehicle establishes a sport-utility category for ATVs. Sure, it hauls haystacks and lugs logs, but mostly, it's a blast.

The Lakota 300 ($4,300) stakes out middle ground in Kawasaki's expanding ATV lineup, which ranges from the all-play Mojave 250 to the tractorlike Bayou 400 4x4. The Lakota hopes to be more things to more people by combining a workhorse 290-cc four-stroke engine and dual cargo racks with a lightweight frame and high-tech suspension (double-wishbone in front). With an optional hitch, it can pull a 650-pound load. And it more than pulls its weight in thrills, nimbly cornering and climbing rough terrain without the leaden-feel handlebars of bigger ATVs. Even mud higher than the floorboards and wire around the axle didn't stop the Lakota.

But in true sport-utility fashion, the Lakota can be civilized too. Its push-button electric starter and five-speed clutchless transmission (with reverse) make it a machine almost anyone can ride—if only from the backyard to the curb.—*Chris O'Malley*



A lighter frame and more forgiving suspension make the Lakota 300 easy to handle.

Copyrighted material

SAFETY

BRAKE-BY-WIRE

A series of innovative brake technologies, most of them advances in antilock braking systems, are being tested by ITT's automotive division. Traction control and antilock brakes are commonplace today. Both rely on a computer precisely monitoring wheel speed and intervening at each wheel either to apply a brake to a spinning wheel, or releasing pressure to avoid a lockup.

An experimental Mercedes-Benz and Audi are fitted with a system that uses the brake pedal only as a signal generator to a computer that directs braking strategy. A simplified system on the Mercedes actuates ABS without the characteristic "chatter"—the brake pedal is isolated from the hydraulics. The Audi's brakes are actuated not by the pedal, but by a tiny knob on the gearshift lever—demonstrating that the pedal is no longer necessary.

Neither system is practical for a production car, but the elements can be developed to allow computer-controlled brakes that detect whether a stop is a "panic" and needs full braking, or that combine with forward-seeking radar for an active cruise control. ITT anticipates that for brake-by-wire to be fully effective, the company will eliminate hydraulics as well, using a completely electromechanical braking system.

At the other end of the spectrum of complexity, a low-cost ABS suitable for small cars eliminates the pump on most ABSs. Instead, reserve hydraulic fluid in an oversize reservoir actuates the system.

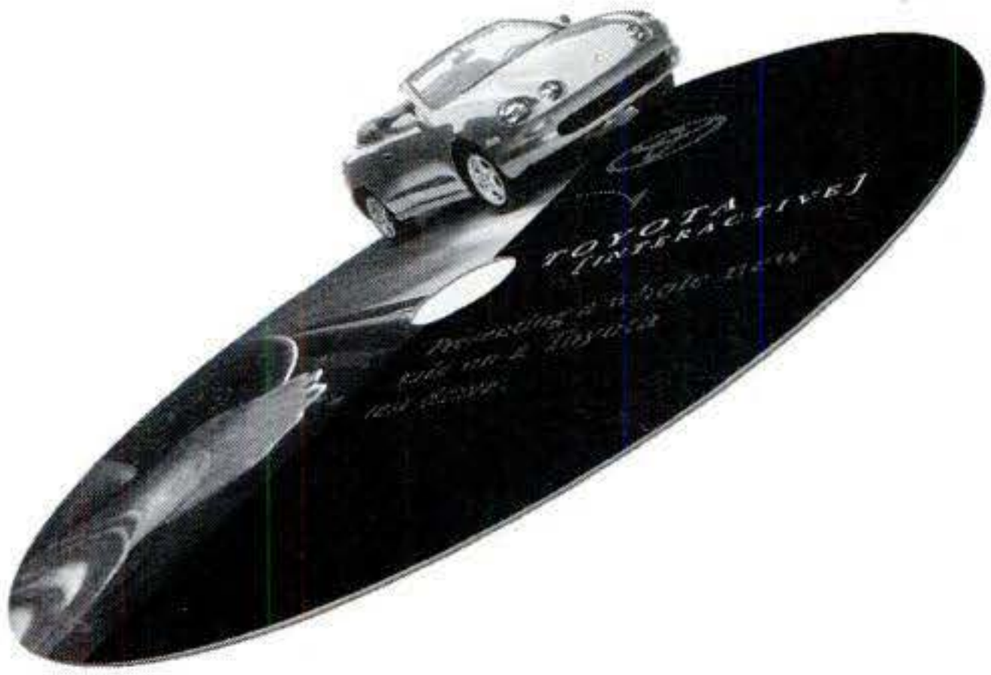
MATERIALS

SUPERSTRONG ZINC

One of the oldest alloys known to man, zinc's low melting point allows making die castings quickly and cheaply. Zinc also was popular for trim pieces on cars; a few decades ago, the average car contained about 40 pounds of zinc castings. But the alloy is weak and brittle, which limited its use to nonfunctional items.

But recently, researchers at General Motors have come up with a family of new zinc alloys. They're relatively cheap and fast to cast but are also stronger than brass or aluminum. Called AcuZinc, the new alloys' strength and dimensional properties let automakers craft components in complex shapes that require no machining. PS

Toyota wants to DRAG you CLICKING and SCREENING into the 21st CENTURY.



Imagine live footage of every Toyota Car, Truck, SUV and Van in any COLOR or from any ANGLE, right in front of your EYES. With all the information of every brochure right at your fingertips. All in full STEREO.

That's what you get — and a whole lot MORE — with Toyota's new free CD-ROM. Call 1-800-GO-TOYOTA today.

TOYOTA

I Love What You Do For Me

©1995 Toyota Motor Sales, U.S.A., Inc. Buckle Up! Do it for those who love you.

Two American Classics

1962 Corvette Convertible

Passport 4500 Radar/Laser Detector

You may not be able to afford a classic Corvette convertible – yet, but you can own the best radar/laser detector designed for serious drivers: the classic Passport 4500 SuperWide. It detects all traffic radar and laser bands and is now the best value as well: total 4-band radar and laser protection is only $139.95. Order yours today.

Passport 4500 SuperWide $139.95 new price!

features: Total radar/laser protection, Patented anti-falsing system, SmartShield™ VG2 protection, Audible & visual alerts, Band Indicators, AutoDim, Mute, AutoMute, Highway/City Modes, Volume Control

Money Back Guarantee!

ESCORT
Department 401675
5200 Fields-Ertel Road
Cincinnati, Ohio 45249

for classic road protection, call toll-free:

1·800·433·3487

Open 24 hours a day, 7 days a week

Shipping & handling is extra. OH res. add 6% sales tax.

© 1995 CMI

Copyrighted material

SURGEON GENERAL'S WARNING: Cigarette Smoke Contains Carbon Monoxide.

© 1995 B&W T Co

100's, 16 mg. "tar", 1.2 mg. nicotine av. per cigarette by FTC method.

Homelite®

For Starters, It's Push-Button.

The New Push-Button Start Trimmer. Just squeeze the trigger, push the button, and trim. It's that fast! But there's more.

The tough new 2-cycle gasoline-powered model is an easier, quieter, slimmer trimmer. Not to mention, it's affordably priced.

So start making yard work easier with the push of a button.

Do it right. Do it Homelite.

Homelite®

Available at your Homelite dealer and other major retailers. Or call 1-800-467-5150.

©1995 Homelite, inc. / A Subsidiary of Deere & Compa

HOME TECHNOLOGY

EDITED BY JUDITH ANNE GUNTHER

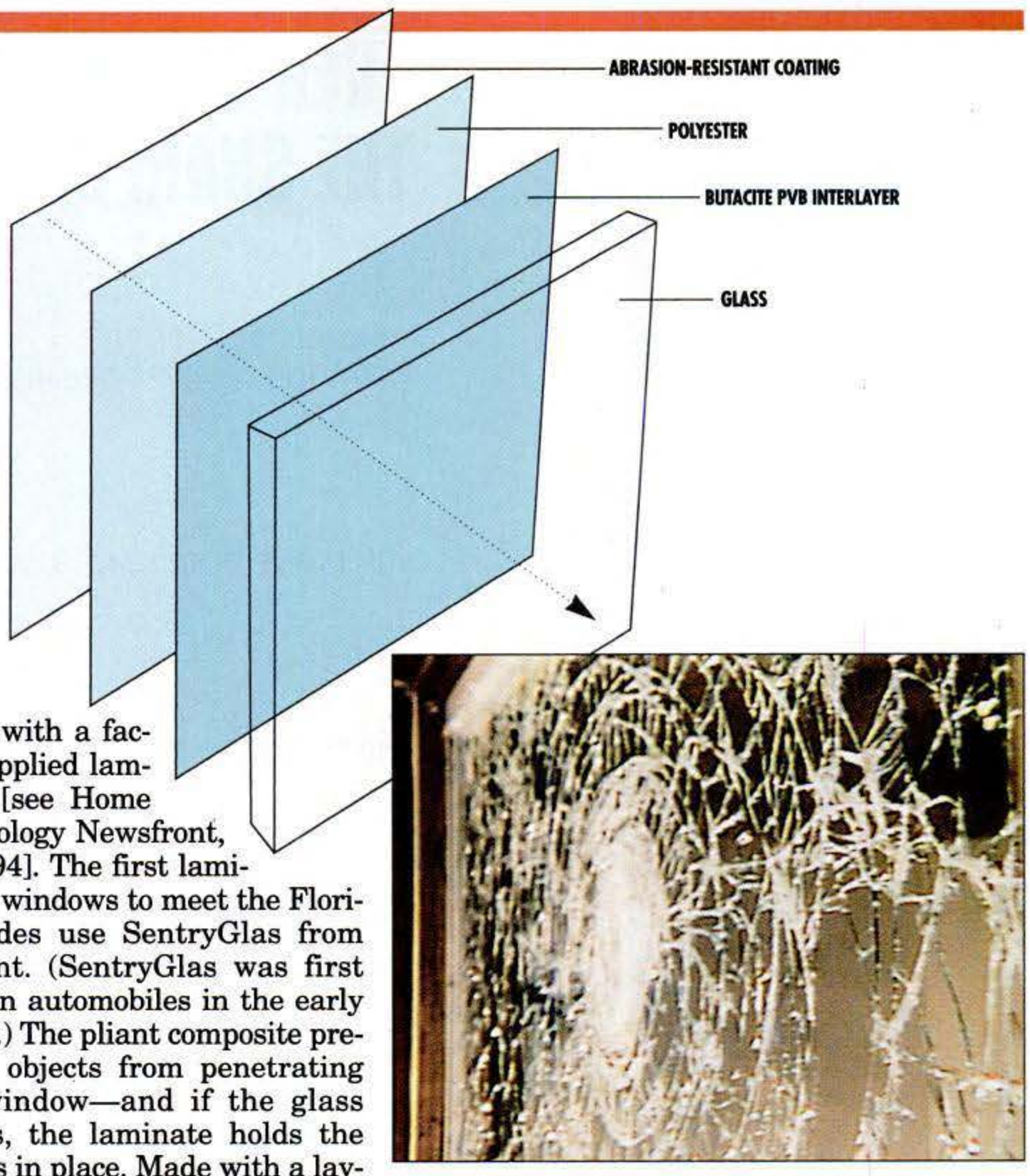
BUILDING TECHNOLOGY

HURRICANE HELPERS

As hurricane season returns to southeastern states, stricter building codes mandate the use of windows that stand up to windborne debris. And new research may also lead to walls that better resist ravaging winds.

Hurricanes inflict much of their damage when a window or wall is punctured, enabling wind to generate increasing pressure inside the house; this stresses the roof and walls. The Florida counties of Dade and Broward now require windows to withstand the impact of a nine-pound two-by-four board traveling at about 35 mph. The window also must endure thousands of cycles of pressure changes.

Homebuilders can meet the codes by installing steel shutters or windows made with a factory-applied laminate [see Home Technology Newsfront, Feb. '94]. The first laminated windows to meet the Florida codes use SentryGlas from DuPont. (SentryGlas was first used in automobiles in the early 1980s.) The pliant composite prevents objects from penetrating the window—and if the glass cracks, the laminate holds the shards in place. Made with a layer of polyester and polyvinyl butyral, the transparent laminate adds no more than .05 inches to the thickness of the glass. Six Florida manufacturers now sell windows laminated with SentryGlas, including Keller Industries in Ft. Lauderdale, Yale Ogron Manufacturing in Hialeah, Progressive Glass Technology in Venice, and Kinco Ltd. in Jacksonville. The windows cost about $21.50 per square foot of glass.



A thin, transparent laminate prevents a single-pane window from being punctured by a nine-pound board.

Because walls also can be punctured, University of Florida civil engineer Duane Ellifritt blasts eight-foot two-by-four beams at the corrugated-metal walls commonly used in commercial construction. The flying two-by-four easily pierces two clamped sheets of 3/4-inch plywood.

Corrugated steel "tends to deflect a large amount of energy," he says. He predicts the material may become a more popular choice for residential construction. Masonry, often used in southern homes, would probably not fare well against two-by-four battering unless it were heavily reinforced, he adds, "because it's so brittle."

Which material is the most hurricane-hardy? Ellifritt says the top performer in his tests is a prototype panel made of two sheets of steel that sandwich a 1/4-inch-thick layer of rubber. Because the steel-and-rubber panel is still under proprietary development, Ellifritt could not reveal its manufacturer.

R & D

TWO-IN-ONE APPLIANCE

After space heating and cooling, water heaters and refrigerators are the biggest energy users in the typical American home. One of these appliances heats water; the other produces excess heat. These two functions seemed complementary to a group of engineers who have built a combined refrigerator and electric water heater, which uses the warmth expelled by the refrigerator to heat water.

The water tank can be placed above or below the refrigerator and freezer compartments in the combo appliance designed by Davis Energy Group in Davis, Calif. "It looks like a tall refrigerator," says Dick Bourne, the group's president.

Saving energy and space is only one of the design's advantages. It also provides instant hot water at the kitchen sink, because the heater is only a few feet away.

The product is still only a prototype, and no estimates of the price have yet been made. But in new homes, the combination would deliver savings over separate appliances, because shipping and installation costs would be less.

A unit installed in a Pacific Gas & Electric Co. test home is used to preheat water, which is then piped to an auxiliary water heater. "But in our ideal application, the combined refrigerator and electric water heater is a standalone unit that replaces the conventional water heater," says Bourne.

Preliminary tests revealed one potential problem: When homeowners are away, no hot water is used, but the refrigerator continues to heat the water. The Davis engineers fixed the problem by adding a mechanism that dumps excess heat into the room.

The two-in-one appliance is best suited for the sunbelt, because the design essentially converts refrigerators from space heaters to water heaters. It is particularly ideal for apartments, which usually require less hot water than houses, but almost as much refrigeration.—*Dawn Stover*

Copyrighted material

10 inch, Contractor Series radial saw

3/4 HP Contractor Series belt/disc sander

12 1/2 inch Contractor Series planer/molder

12 inch, 1 1/8 HP band saw with tilt head

20 inch Contractor Series variable speed scroll saw

EVEN WITHOUT THE BLADE, IT'S PROBABLY THE SHARPEST SAW YOU'LL EVER USE.

WITH AN EXCLUSIVE T-SQUARE RIP FENCE, A POWERFUL 4,800 RPM,

2HP, 15 AMP MOTOR, ANTI-KICKBACK PAWLS, CARBIDE-TIPPED BLADE

AND THE ABILITY TO CROSS, RIP, MITER AND BEVEL,

THE CRAFTSMAN TABLE SAW SYSTEM IS ONE OF THE

SMARTEST TOOLS YOU'LL EVER LAY YOUR HANDS ON.

OF COURSE, WITH CUTTING ABILITIES LIKE THAT,

YOU'LL BE LOOKING PRETTY SHARP YOURSELF.

CRAFTSMAN®

EXCLUSIVELY AT SEARS AND SEARS HARDWARE STORES

Copyrighted material

© Sears, Roebuck and Co. 1995

APPLIANCES

HIGH-I.Q. MICROWAVE

No need to guess how much reheating time that frozen lasagna will need—the world's first artificial intelligence microwave oven decides for you. Sharp's Neurologic R-4N76 uses neural networks—a type of computer circuit modeled after the human brain—to estimate when a dish is sufficiently heated.

The relative "doneness" of food can be predicted by humidity levels in the oven, explains Sharp's European lab director, Clive Bradley. The oven's microprocessor stores a record of the varying humidity over time for different types of foods. By comparing the preprogrammed data to the actual humidity in the oven as an unknown food cooks, the neural networks can determine how much more time is needed. All you do is press Start. The oven even tells you when to stir.

There are, however, two drawbacks. The technique works only with liquids or frozen foods—not fresh foods, which have more complicated cooking characteristics. Also, Sharp is selling the smart oven only in England, for about $400.—*Robert Langreth*

SOLAR ENERGY

PLUG-IN KITS?

Sometime in the not-so-distant future, you may be able to purchase all-in-one photovoltaic panel kits at your local hardware store. Each kit would contain the necessary hardware and circuitry; all you'd have to do is mount the device on your roof and plug it in.

John Bzura, a principal engineer at New England Power Service in Westborough, Mass., says the project could make photovoltaics more affordable and easier to install. A key goal of the project is to shrink the inverter—the device that turns the direct current produced by the solar panel into alternating current—down to an unobtrusive size, "about the size of a dictionary," Bzura says. (He says they are typically 20 times larger than that.)

Bzura expects the kit to include a single 300-watt panel, which measures approximately four feet by six feet—large enough to run your television, VCR, and stereo system on a sunny day. The kit may be commercially available within five years; Bzura says it's too early to determine the retail price.

Smashed—rather than chopped—wood in scrimber means a stronger beam.

MATERIALS

SCRUNCHED LUMBER

To make those increasingly popular beams of "engineered" lumber, manufacturers have used wood that's been peeled, chopped, and even chipped. But for a better beam, say some, you can't beat smashing whole logs.

Scrimber, an engineered lumber developed in Australia, starts with debarked logs. The logs are crushed between rollers. The resulting mat next receives a dose of adhesive. Lastly, the wood is pressed into a block and cut into beams up to 40 feet long. Compressing the wood, rather than chopping it, retains more of the long, unbroken cellulose fibers that give natural lumber its strength.

Georgia-Pacific of Atlanta is now exploring scrimber's commercial practicality. If the company can perfect the manufacturing process, scrimber could substitute for whole sawn lumber in many applications that require structural strength. Tests with southern yellow pine will continue for a year.—*Mariette DiChristina*

HOME AUTOMATION

SMARTS AT LAST?

Ten years ago, Electronics Industries Association members gathered with a mission: to determine how home appliances and electronics equipment would "speak" to each other to provide home automation. Today, 1,400 pages of written standard later, you can finally benefit from systems that use this "language," called CEBus.

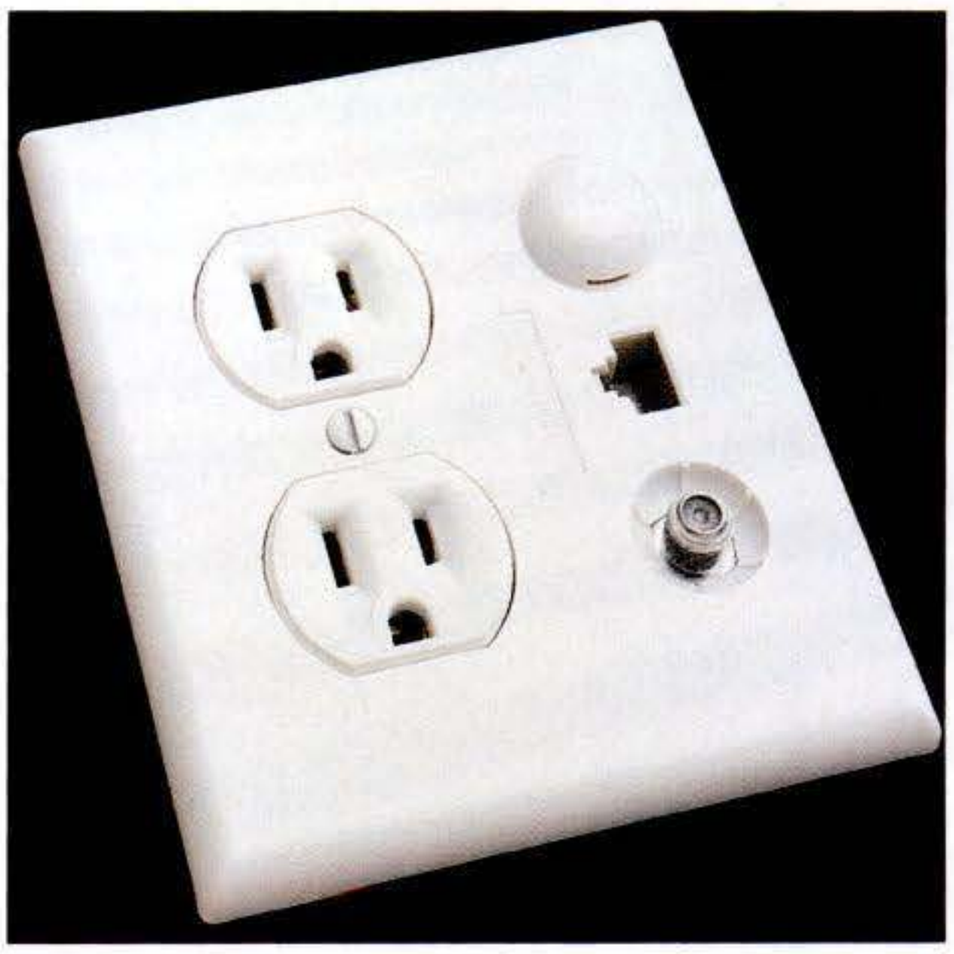
CEBus is short for the Consumer Electronics Bus—a bus being a pathway for data signals; products will communicate through this bus. For instance, your dishwasher might query your electricity meter about when it will cost the least to run a load.

Among the first CEBus systems is U.S. Tec's TecSystem local area network. Its two coaxial cables, phone, and electrical wiring provide the communication "telephone lines." Unique wall plates called TecPlates (photo below left) give access to these services. A setup with eight TecPlates costs about $1,500 installed.

Another CEBus offering, IES Technologies' FutureSmart Interactive Network System, includes two coaxial cables and eight phone wires, which provide a hookup for a home local area network as well as multiple phone lines; the system also adds two fiber-optic lines for future high-speed communications. A setup for eight outlets would cost approximately $3,000 to $3,500.

With their built-in smarts, CEBus products could all theoretically "talk" to each other—but right now, they won't always easily do so. For instance, all of one manufacturer's equipment might communicate, but the codes could sometimes be gibberish to products made by another. That's why, for now, U.S. Tec and IES include a central controller that acts as a translator.

New products that can work with these systems include zoned home air-conditioning and heating equipment from the Trane Co., Ademco's Vista line of security networks, and a series of lighting controls from LightTouch.—*Suzanne Kantra Kirschner* PS



TecPlates combine electrical wiring, a phone line, and two coaxial cables into one access panel for home automation.

Copyrighted material

IN ADDITION TO FURNITURE AND CABINETRY, IT'S ALSO QUITE GOOD AT BUILDING REPUTATIONS.

THE CRAFTSMAN PLUNGE ROUTER. IT HAS A 3 1/2 HP SOFT-START MOTOR TO ELIMINATE JUMPING. INFINITE DEPTH SETTINGS. ELECTRONIC SPEED CONTROL TO ADJUST TO WOOD HARDNESS. AND HANDLE-MOUNTED FINGERTIP CONTROLS. ADD TO THAT A SELECTION OF OVER 200 DIFFERENT ROUTER BITS AND ACCESSORIES AND YOU WON'T JUST BE WORKING WOOD, YOU'LL BE WORKING MIRACLES.

CRAFTSMAN®

EXCLUSIVELY AT SEARS AND SEARS HARDWARE STORES

Sears, Roebuck and Co. 1995

Copyrighted material

ELECTRONICS

EDITED BY MICHAEL ANTONOFF

INTERACTIVE TV

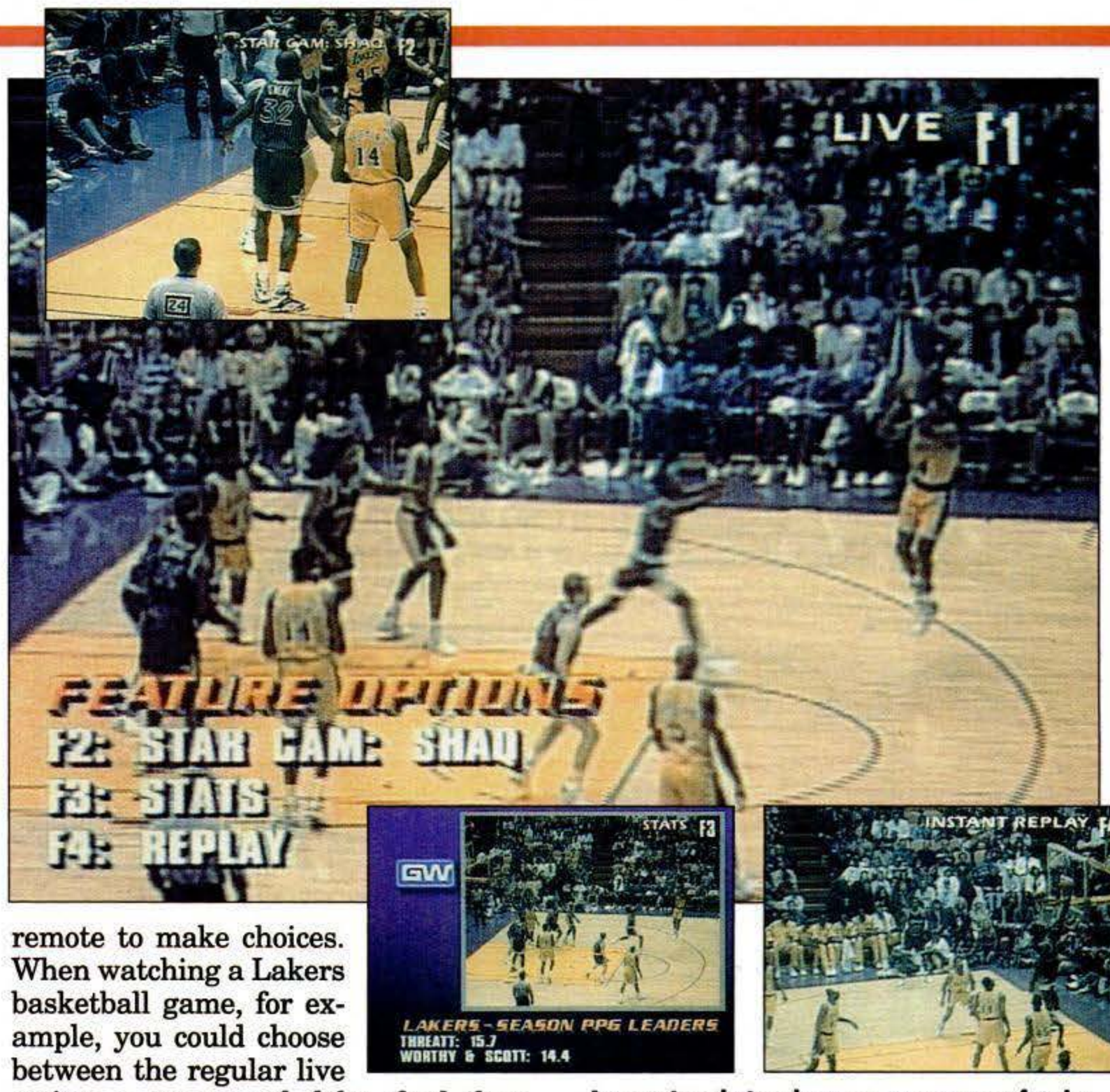
YOU DIRECT THE SPORTSCAST

For a group of viewers in suburban Los Angeles, the choice is not simply what program to watch but which camera angle to select. The L.A. Project, as it's known, is a peek into a more personalized form of television. By September, 1,000 Ventura County Cablevision customers will have unprecedented control of how they watch TV. New York-based ACTV is supplying the programming in conjunction with Prime Sports and Turner Educational Services.

The L.A. Project, a free trial, is patterned after a system in Montreal called Videoway, now in its fifth year. California users receive special cable boxes that allow them to select the interactive channel: educational and game shows during the day, news at dinner time, and sports in the evenings and on weekends.

Viewers use a special four-button remote to make choices. When watching a Lakers basketball game, for example, you could choose between the regular live action; a ten-second delay feed that lets you select your own instant replays; a "star-cam" focused exclusively on a key player; or a statistics screen. Just before the commercial break, viewers will be able to choose which of four ads they'd like to see.

David Reese, president of ACTV's entertainment division, expects the service to eventually cost customers between $6 and $10 per month in addition to the basic cable charge. There will be no extra fee for use of the box, which also receives all other cable channels.—*Jeff Hecox*



At any time during the game, you can opt for the studio director's camera selection or switch to a close-up view of a star player, a statistics screen, or a ten-second delay.

R & D

GYRO ON A CHIP

Two inventors from northern Louisiana may have created a better electronic compass.

Billy Smith and John Gay of West Monroe, La., say their patented new 3-D compass improves upon the reliability and operating speed of conventional electronic compasses. The Navicube, as they call the matchbox-sized 3-D gadget, has no moving parts; is not susceptible to interference from electronic devices or iron objects like most other compasses; is accurate to less than one-tenth of one degree; and responds almost instantaneously without getting disoriented, no matter how quickly you turn it. Moreover, because it is a semiconductor, the Navicube will be able to fit on a chip.

The compass works on a well-known principle of physics called the Hall effect. When current passes through a sheet of conducting material in the presence of a magnetic field, the charge will spread out to the edges of the sheet. The amount of charge that builds up on the edges depends on the orientation of the sheet relative to the magnetic field.

Earth's magnetic field is easily large enough to trigger this effect; in fact, physicists have batted around the idea of exploiting the Hall effect to create a compass since the 1960s, according to physicist Larry Rubin of MIT's magnet lab. But Smith and Gay appear to be the first to actually build such a device. "Their performance numbers sound legitimate," Rubin says.

The two stumbled onto the concept while trying to design a tracking device for head-mounted displays used in virtual reality applications, an area for which they hope to market the device. It could also help navigate a car. The inventors also believe the Navicube can aid the disabled. For example, a Navicube connected to a voice synthesizer might one day help a blind person get around.
—*Robert Langreth*

VCRs

GET READY FOR D-VHS

Owners of Super-VHS (S-VHS) video recorders are accustomed to watching time-shifted programs that nearly match the picture quality of the real-time broadcast. Now that the bar has been raised by the Digital Satellite System, the degree of image degradation as seen on tapes recorded via the prevailing VHS-type of VCR is undeniable.

By the middle of next year, RCA Thomson expects to be selling a Digital VHS (D-VHS) recorder for $500 to $600 that will transfer the bitstream from DSS receivers to a half-inch cassette. The recording can only be viewed when decoded through the DSS receiver. RCA's DSS and DSS II receivers will not connect to the D-VHS VCR. You'll need a DSS III receiver available when D-VHS ships. D-VHS will also record and play back analog broadcasts and standard VHS cassettes.

Copyrighted material

Hands On

Atari's Jaguar

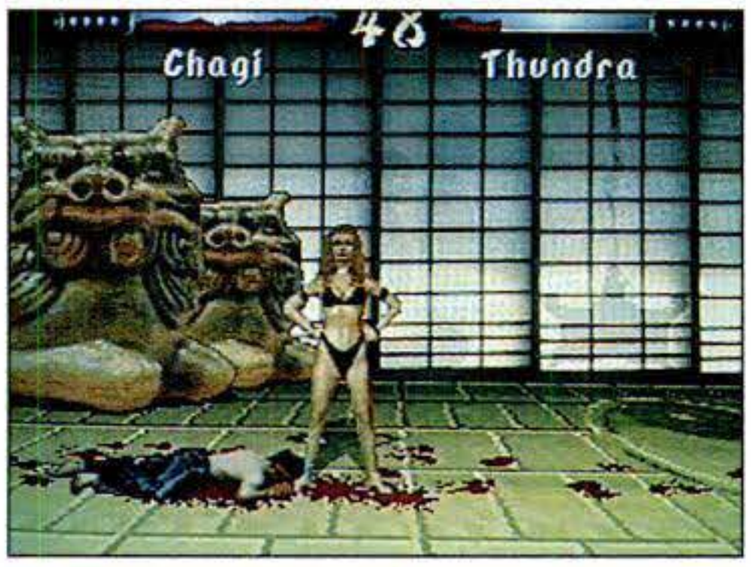
With a new price just slightly higher than the Super Nintendo and Sega Genesis systems, Atari's 64-bit Jaguar offers a video-gaming experience with quality near that of an arcade. Originally selling for $249, the Jaguar has been marked down to $159, about $30 more than 16-bit systems like the Genesis and about half the price of other next-generation systems.

Rather than streaming game code through a single processor, the Jaguar has specialized processors working in tandem. Its Graphics Processor and Object Processor enable it to create large, realistic characters and detailed scenes. After completing the Jaguar version of Doom, John Romero, one of the creators of the popular computer game, rated the Atari game system as one of the best.

Jaguar accepts a plug-in game cartridge and up to two controllers.

Complementing the graphics engine is a Digital Signal Processor that produces 16-bit stereo sound. Though some games do not take full advantage of the Jaguar's audio power, games like Tempest 2000 demonstrate the excitement that a stereo soundtrack can add. But because Jaguar connects through your TV's coaxial antenna port, it's less flexible than game systems equipped with video and dual audio jacks.

All of its processing power makes Jaguar a strong system for innovative games. Superimposing animated skiers against a stunning, panoramic backdrop of the Alps, Val d'Ise're Skiing and Snow Boarding twists, turns, and drops you at such dizzying speeds you'll feel your stomach bounce. As you hurtle through the course, obstacles test your reflexes. You may slide wildly on ice or leap over patches of dirt. Trees and snowplows can cause nasty spills, but there's no time to lick your wounds:



In Kasumi Ninja, the amount of blood ranges from none (top) to gore fest (bottom).

You scramble to your feet as you race the clock to the next checkpoint. In Kasumi Ninja, a slick martial arts game, parents can lock out an option in which blood sprays and drips and fights end in death.

There were 25 titles in stores for Jaguar as of April. A $150 CD player and additional games have been announced, which will make the system more competitive with 3DO and the forthcoming Sega Saturn. As for now, Jaguar is a huge step up from similarly priced 16-bit game consoles. —*Steven L. Kent*

Telephones

25-Channel Cordless Models Debut

Until now, most analog cordless phones have relied on ten frequencies between 46- and 49MHz to search for a clear channel. But with a recent FCC ruling extending the lower range to 44MHz, manufacturers are starting to deliver phones with 25 channels. This means you'll be less likely to pick up the sound from a nearby baby monitor or chatter from fleet vehicles while using a cordless phone.

All 25-channel phones are required to have automatic channel scanning to locate a free channel. This should minimize interference from mobile two-way radios that overlap the lower frequencies of the new cordless phones. You'll need to place the base station of a 25-channel cordless phone at least a couple of feet away from your television set, which operates internally at approximately 44MHz.

The first phones were expected in June from AT&T and Philips, and later this summer from Sony. They'll cost approximately $100 for basic models, although the Philips CLT250 does include an infrared TV/stereo mute button for the price. The remote is "trainable": Simply point the TV remote at the phone and press the mute function to capture the code. Uniden, Panasonic, and Cobra plan to introduce their phones this fall.

Audio

Leashless Museum Tours

I press "30" on the keypad of the black batonlike device, the number for the Sea World exhibit—flamingos—that I want to know more about. Before playing my selection, the device silently ticks off three seconds, enough time for me to lift the unit against my ear. A crystal-clear recording then explains how the birds get their pink plumage.

I am using Inform, a new digital audio guide for museums and other attractions from Acoustiguide of New York, the company that pioneered audiotape guides in 1957.

Unlike cassettes, Inform doesn't lock visitors into a rigid itinerary; you can select information on exhibits in whatever order you like. The handheld guides also aren't subject to interference, as are radio wands. First used at the Louvre in Paris in 1993, Inform has now been installed in more than a dozen places around the world.

Developed by an Israeli company called Espro, the 13-ounce units are stored in a recharging rack. The solid-state chip in each Inform can be reprogrammed in minutes for a new exhibition by inserting a different memory flash card into the charger.

Inform will soon incorporate infrared technology, to provide film and video synchronization—so you can walk up to any video screen and have it match your audio tour. Inform's rental rate varies by museum.

Still think you might miss the familiar old cassettes? Don't fret: When you hit the fast-forward button on Inform, you get the gratifyingly analog-sounding purr of sped-up words, just as you do with tapes.
—*Mariette DiChristina*

Digital audio museum guides let you key in each exhibit to get the information in any sequence.

Copyrighted material

GE
CG400

CAMCORDERS

BACK TO BASICS

MINOLTA MASTER
C-503

The first thing you'll notice when you look at the recent crop of camcorders from Sanyo, Minolta, GE, and JVC is their lack of buttons. And the buttons are not lurking behind panels to simulate simplicity. They don't exist.

While a dearth of special effects may be anathema to the home video enthusiast—especially since a small number of features doesn't add up to a small price in all cases—these point-and-shoot models could be a blessing for the video-challenged parent who craves a no-nonsense way to record baby's first steps.

If you want an 8mm camcorder, you have two choices: Sanyo's VM-PS12 or GE's CG400, which are functionally identical but differ in price. The Sanyo model costs $499 and the GE (from Thomson Consumer Electronics) is $599. These camcorders feature manual 3x-magnification zoom lenses, a black-and-white optical viewfinder, and fuzzy logic that determines the appropriate shutter speed and white balance for the best-looking picture. At 1.4 pounds plus battery, they weigh the same as Minolta's Master C-503 and JVC's GR-EZ1. The latter two use VHS-C cassettes. I found them more comfortable to hold.

The Minolta and JVC cameras include date titles, 3x-magnification power zoom, and the ability to record sequences in five-second spurts to control pacing—a boon for audiences weary of home videos that run on endlessly. The cameras also feature an instant re-shoot capability in which the tape is wound back to the beginning of the just-completed scene. The only obvious difference is in the viewfinders. The Minolta Master C-503s is color, for which you'll pay about $150 more.
—*Suzanne Kantra Kirschner*

BRAND	GE	MINOLTA	SANYO	JVC
PRICE	$599	$752	$499	$599
TAPE TYPE	8mm	VHS-C	8mm	VHS-C
VIEWFINDER	b/w	color	b/w	b/w
WEIGHT (lbs., w/o battery)	1.4	1.4	1.4	1.4

SANYO
VM-PS12

JVC
GR-EZ1

R & D

MAKING BETTER HOLOGRAMS

A limitation of holograms—light interference patterns on photographic plates that produce apparent three-dimensional images—is that they're most visible from an oblique angle. (If you don't believe this, peer at the holographic icon on a credit card. Straight on, it appears flat.) That makes holograms nearly useless for billboards.

Now Carl Amos, an inventor and electrical engineer in Reston, Va., has patented a new lens for producing holograms that can be viewed from any angle. Holograms are produced by reflecting two laser beams off an object and onto a special photographic surface, burning a 3-D image of the object into the plate; however, the image can only be seen by looking at the surface from the same angles at which the lasers entered the plate. Amos' lens, shaped like a hollow glass wedding cake with mirrored sides, spreads the laser light over a large area on the surface where the hologram is to be recorded. No matter where a viewer stands later, he is almost always at an angle where the laser entered the plate.—*R. L.*

RADIO

JUMPSTARTING RBDS

The logjam has broken for RBDS, the Radio Broadcast Data System that displays station call letters and song titles and issues emergency bulletins and other messages on a new breed of FM car and home receiver. While a hit in Europe, this "Smart Radio" service has been slow to pick up support in the United States from broadcasters or equipment makers—each waiting for the other to make a decisive move. Now the Electronic Industries Association and several member companies are breaking the ice by funding the installation of encoders and software at 500 FM stations in the top 25 markets, touching 85 percent of the population. In return, participating stations agree to air promotions and to carry RBDS for three years.

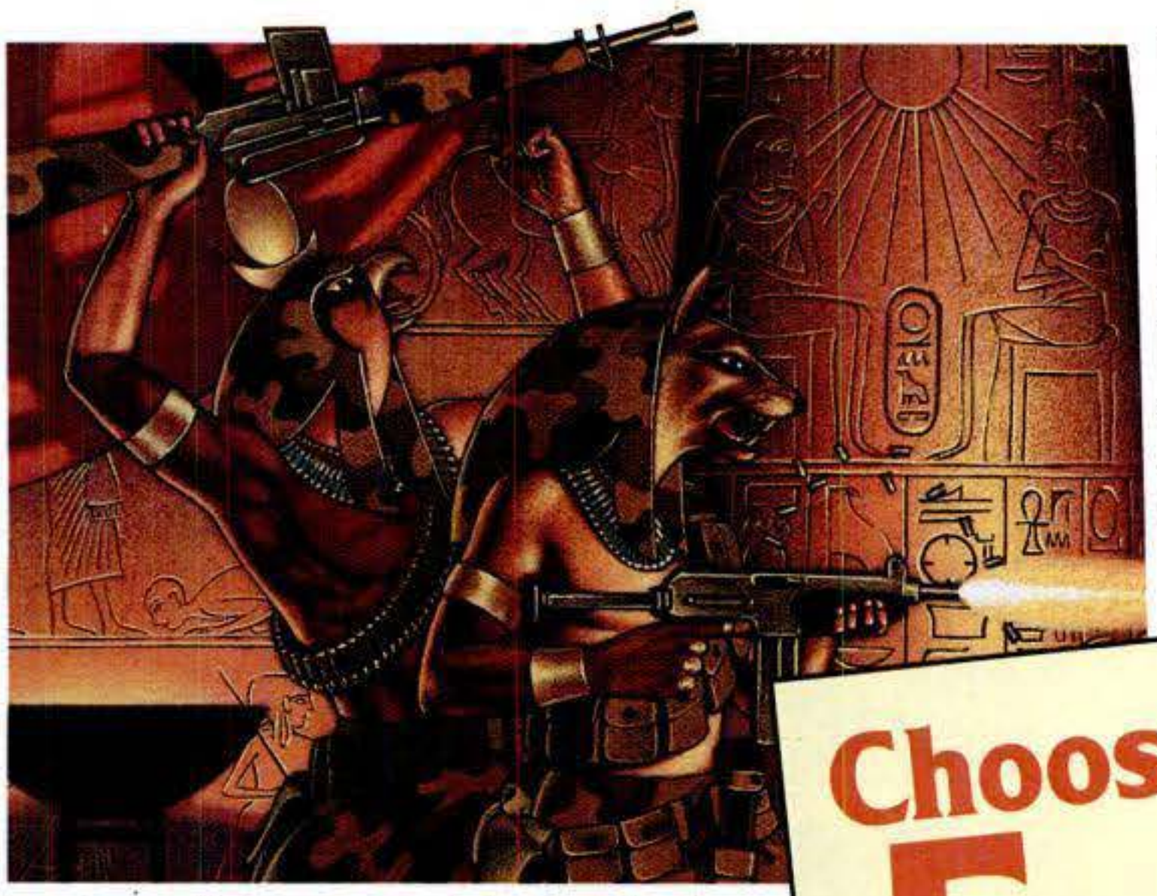
Beamed on a radio subcarrier at 57MHz, the system claims a slight 1 to 2 percent of a station's power. Yet the Smart Radio digital data stream offers assorted functions, including automatic clock adjustment, private paging, and a traffic-alert option that automatically pauses a CD or cassette to switch on a bulletin. Radios can be set to tune in stations offering a specific type of programming such as talk, rock, or religious broadcasts. Though the typical radio LED is limited to one or two lines of eight characters each, RBDS can send and show text in 64-character chunks scrolling continuously across the screen when the data circuit is engaged.

National Public Radio stations are exploiting the "alternate frequency" feature that automatically retunes a car radio to the next strongest signal carrying the same program. So you need never be without the public radio program "Fresh Air," for example.

Philips and GM's Delco division now offer car radios with the system, while major booster Denon has both auto and home receivers and Grundig markets "smart" multiband portables. For the multimedia computer crowd, Advanced Digital Systems recently introduced an RBDS FM card, Radio Rock It ($250), that plugs into a 386DX or higher PC.

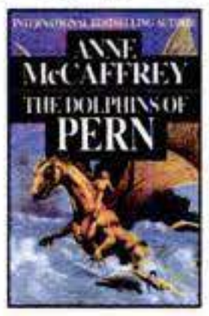
Waiting in the wings: Blaupunkt, Goldstar, International Jensen, and Pioneer with RBDS products, and a complementary high-speed FM subcarrier service (using adjacent frequencies) that could convoy much denser data streams onto the "info superskyway."—*Jonathan Takiff* PS

Copyrighted material



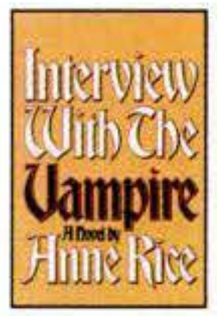
If bookstore prices have *you* up in arms, just fire off the coupon below...

Choose any 5 for $1 with membership



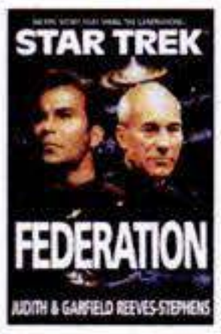
0604 $22.00/**$11.98**

0356 $23.95/**$12.98**



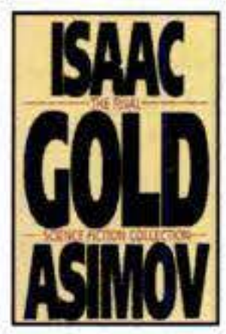
0208* $23.00/**$8.98**

0786† $19.95/**$9.98**

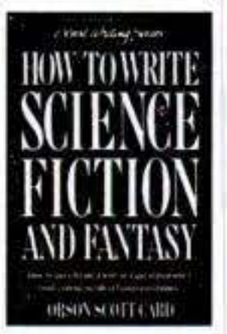


0927+ $22.00/**$10.98**

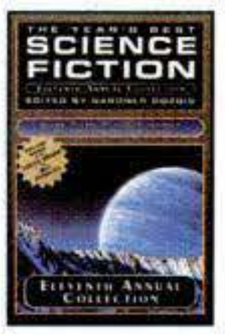
0760 **$11.98x**



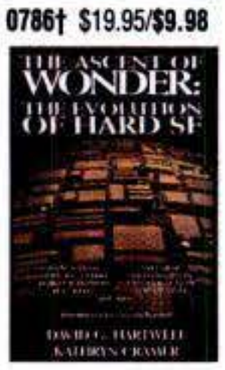
1065 $20.00/**$9.98**



8680 $13.95/**$6.98**

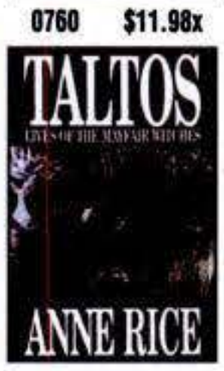


0422* $26.95/**$14.98**

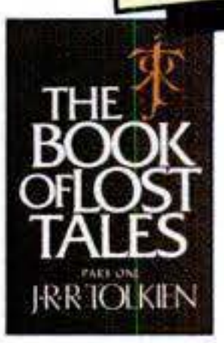


0653 $35.00/**$17.98**

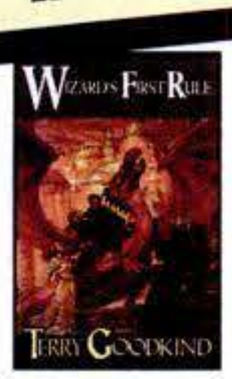
0380* $26.95/**$12.98**



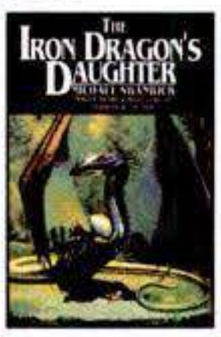
0521* $25.00/**$11.98**



1362 $14.95/**$7.98**

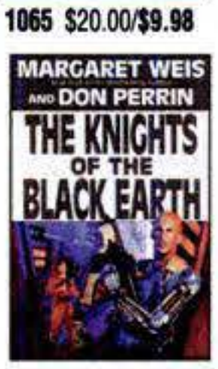


1008* $23.95/**$11.98**

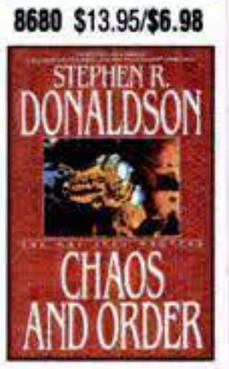


8615* $23.00/**$10.98**

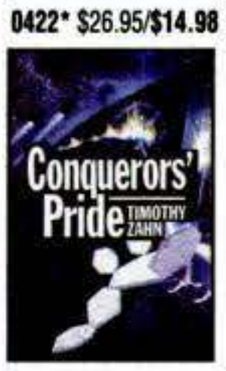
6916 **$12.98x**



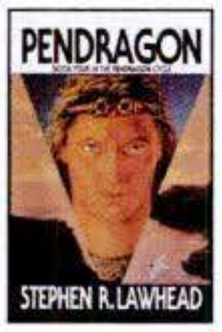
1073 $18.95/**$8.98**



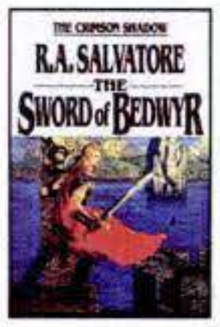
0455* $22.95/**$11.98**



0679 **$7.98x**

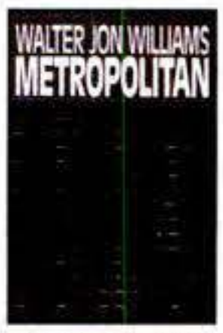


0836 $23.00/**$10.98**

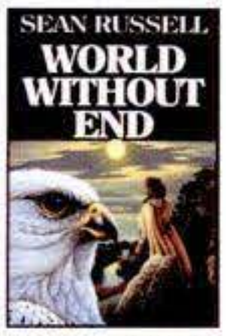


1081 $18.95/**$8.98**

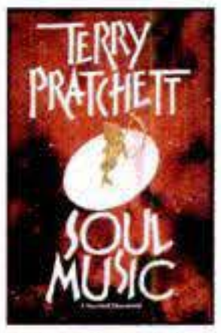
1016 $22.95/**$11.98**



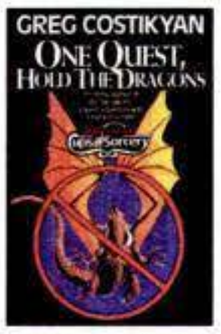
1131 $20.00/**$9.98**



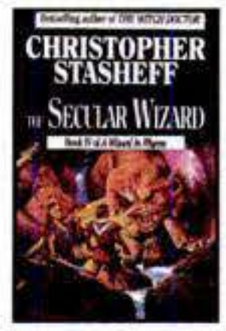
0133 **$10.98x**



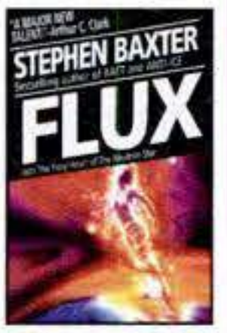
1040 $20.00/**$7.98**



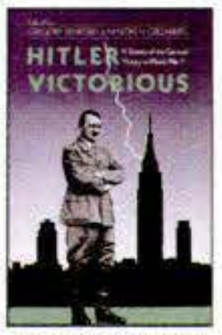
1032 **$7.98x**



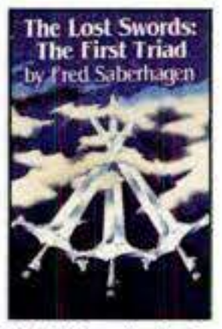
1024 $21.00/**$9.98**



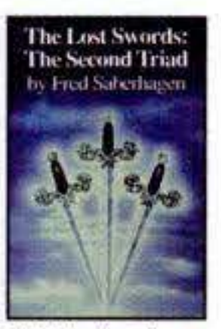
0349 **$8.98x**



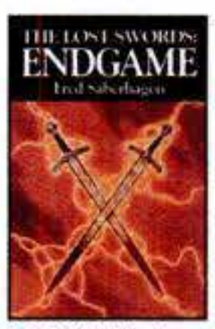
1123 $18.95/**$8.98**



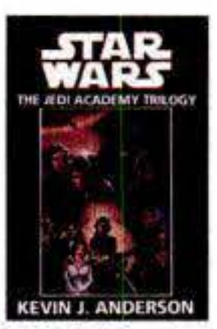
7260 *Woundhealer's Story, Sightblinder's Story, Stonecutter's Story*
$45.85#/**$12.98**



5017 *Farslayer's Story, Coinspinner's Story, Mindsword's Story*
$50.85#/**$12.98**



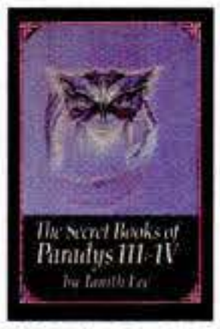
4903 *Wayfinder's Story, Shieldbreaker's Story*
$38.90#/**$10.98**



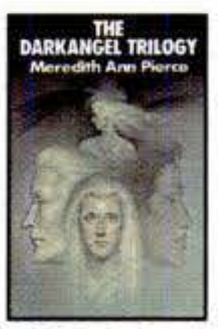
0562◊ *Jedi Search, Dark Apprentice, Champions of the Force*
$14.98x

0968◊ $21.95/**$7.98**

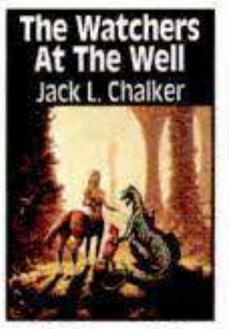
7609* *The Book of the Damned, The Book of the Beast*
$39.90#/**$10.98**



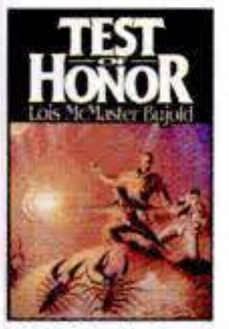
5264* *The Book of the Dead, The Book of the Mad*
$39.90#/**$10.98**



6635 *The Darkangel, A Gathering of Gargoyles, The Pearl of the Soul of the World*
$44.85#/**$12.98**



0596 *Echoes of the Well of Souls, Shadow of the Well of Souls, Gods of the Well of Souls*
$14.98x



0802 *Shards of Honor, The Warrior's Apprentice*
$10.98x

Prices in fine print are publishers' hardcover editions.
Prices in bold print are Club hardcover editions.

Combined publishers' editions * Explicit scenes and/or language
x Hardcover edition exclusively for Club members

+ ™, ® and © 1995 Paramount Pictures. All Rights Reserved. STAR TREK is a Registered Trademark of Paramount Pictures. † © 1994 Marvel Entertainment Group, Inc.
◊ ™, ® and © 1994 Lucasfilm Ltd. (LFL) All Rights Reserved. Used Under Authorization.

HERE'S WHAT YOU GET WHEN YOU JOIN...

A GUARANTEE OF SATISFACTION. Once your membership's accepted, we'll send your 5 BOOKS and FREE CLUB TOTE. If you're dissatisfied with the books, return them within 10 days *at our expense.* Membership will be canceled; you'll owe nothing.

HUGE DISCOUNTS ON HARDCOVER BOOKS. Save as much as *65% off* publishers' edition prices. Club books are sometimes altered in size to fit special presses.

THE FREE CLUB MAGAZINE. You'll receive up to 16 issues a year. Each reviews the Featured Book Selection(s) plus dozens of alternate books.

SHOPPING MADE SIMPLE. To get the Featured Book Selection(s), *do nothing*—it will be sent automatically. If you prefer another book—or none at all—return your Member Reply Form by the specified date. A shipping and handling charge (and sales tax, where applicable) is added to each order.

AN EASY-TO-MEET OBLIGATION. Take up to 2 years to buy 4 more books at regular low Club prices. Afterwards, you may resign membership anytime.

RISK-FREE RETURN PRIVILEGES. If you get an unwanted book because your Club magazine was delayed and you had less than 10 days to respond, simply return the book *at our expense.*

FREE TOTE
with membership

THE Science Fiction BOOK CLUB®

MAIL TO: *The Science Fiction Book Club*
6550 East 30th Street
P.O. Box 6367
Indianapolis, IN 46206-6367

Please write book numbers here:

05

YES! Please enroll me in *The Science Fiction Book Club* according to the risk-free membership plan described in this ad. Send me the 5 BOOKS I've indicated—plus my FREE CLUB TOTE. Bill me just $1, plus shipping and handling.

SAVE EVEN MORE! Send me this book now and reduce my commitment to 3 books. Bill me an added $2.98, plus shipping and handling. (write book number) | | | | | 58245 96

Mr./Mrs.
Miss/Ms. _____
(please print)

Address _____ Apt. _____

City _____ State _____ Zip _____

If you're under 18, your parent must sign here _____

Members accepted in U.S.A. and Canada only. Canadian members serviced from Canada, where offer is slightly different. Sales tax added where applicable. We reserve the right to reject any application. POPSCI 7/95

Copyrighted material

COMPUTERS & SOFTWARE

EDITED BY CHRIS O'MALLEY

DISPLAYS

COLOR FOR THE COLOR BLIND

Most software programs use color to highlight or organize information and to render pictures and symbols accurately. But what about the 8 percent of the male population that has trouble telling red from green, or the smaller numbers of women with the same problem? What do they see when they look at these screens?

This was the seemingly simple question asked by researchers at a Dutch government lab who were working on color displays for the Royal Navy. The obvious answer, of course, is that people with some form of color blindness sometimes have trouble interpreting computer displays correctly. But the Dutch team went a step further toward understanding the problem by developing a simulator that lets a color monitor display any program the way a color-blind person would see it. Now they're working on a solution: a software system that adjusts a computer monitor's red-green-blue output to the needs of the color-deficient eye.

This self-portrait by Van Gogh is shown as it appears to the normal eye (upper left) and to the three major types of dichromatic, or color-blind, eyes.

To diagnose the trouble areas, the software will first administer an on-screen color vision test. Then it will use the results to automatically change the color schemes used by other software so as to accommodate the red-green, or rarer yellow-blue, deficiencies of some eyes. Most software, the researchers note, could be adapted for the color blind with little or no impact on users with normal vision.—*Jonathan Beard*

MODEMS

BABBLE AND BYTES

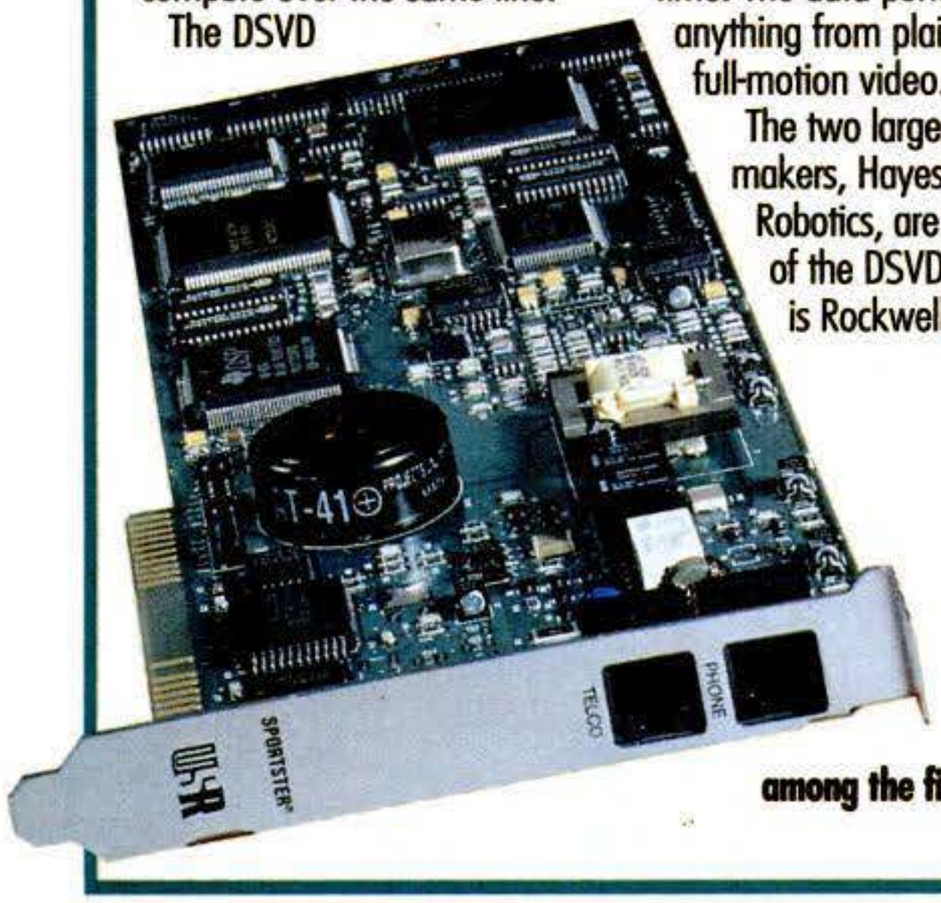
Tired of your telephone and PC modem competing for the same phone line? A new class of digital modems known as DSVD modems will soon enable you to talk and compute over the same line.

The DSVD moniker is derived from the Digital Simultaneous Voice and Data blueprint that several leading modem makers have agreed to follow when designing these new modems. DSVD modems use digital signals for both voice and data; the signals can be compressed and then separated into distinct channels to move through the same phone line at the same time. The data portion can be anything from plain text to full-motion video.

The two largest modem makers, Hayes and U.S. Robotics, are both part of the DSVD group. So is Rockwell, the leading maker of modem chip sets. U.S. Robotics has already debuted its first DSVD modem, called the Sportster Vi 28.8 DSVD. Intel and Creative Labs are also backing the DSVD effort, each hoping the new modems will make their video- and data-conferencing products for PCs more appealing, since only one phone line would be needed.

Simultaneous voice-and-data modems are also ideal for distance-learning applications, in which students can see lessons on their PC screens while hearing classroom discussions.

AT&T earlier developed a similar technology called Voice Span, which it has licensed to several other companies. Neither design has official sanctioning from the International Telecommunications Union yet, however.



U.S. Robotics' Sportster Vi 28.8 DSVD is among the first in a new class of voice-and-data modems.

GAMES

PCS ON THE XBAND

Video game players in some parts of the country have been able to challenge each other over long-distance phone lines for months now, thanks to Catapult Entertainment's Xband network [see "Online Gaming," Dec. '94]. By fall, PC users will be able to join in the fun too.

Catapult is working with Intel to create a PC "space" on the Xband network, which currently lets Sega and Nintendo video game players dial into an online network and match their skills against an opponent who may be dialing in from next door or a thousand miles away. The PC network will work similarly to the video game network, but with different games. Many of the multiplayer games now available for PCs, including some featuring flying and fighting duels, are being adapted for Xband. All you need to play is a PC, modem, and the Xband software.

Catapult plans to offer the software for free, either directly (408-366-1735) or bundled with new Pentium PCs. The service is expected to cost less than $10 a month.

Copyrighted material

MULTIMEDIA

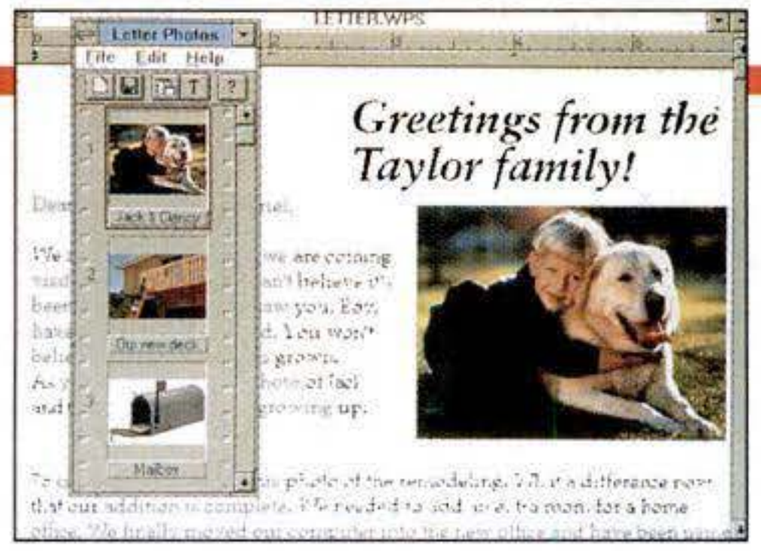
THE DIGITAL FAMILY ALBUM

Tape, glue, and shoeboxes full of jumbled photos have always been part of the rite of organizing and showing family snapshots. But for some families, at least, scanners and mouse clicks may replace all that.

PhotoWorks Plus for Windows from Seattle FilmWorks is part software and part film-processing service. You send in ordinary 35mm film and get back both prints and corresponding picture files on a floppy disk. It costs about $14 to get a 24-exposure roll scanned and sent back with files, prints, negatives, and a new roll of film. The $45 software helps you organize, view, and, if you like, print the images.

Echo Lake from Delrina Corp. lets you build homemade multimedia "books" from scanned-in photos, video clips, artwork, and sound, and even story lines you concoct yourself. The program, $60 in CD-ROM, $50 on floppies, uses detailed screens of living rooms and tree rings as metaphors to organize, create, and display your book. Nothing to talk about? An "inspirator" feature helps recall noteworthy events. The Windows version is available now; a Mac edition is scheduled for late summer.

EasyPhoto is Storm Software's $250 all-in-one digital album maker for anyone with a Windows PC and a CD-ROM drive. It comes with a small color scanner that reproduces your prints onscreen, and the software to view, organize, edit, and print them. You can also view images saved in Kodak's Photo CD picture file format.



EasyPhoto (top), Echo Lake (middle), and PhotoWorks Plus (bottom) each give you a different set of tools to help you view, organize, store, and share family photos with a PC.

Sharing the photos in your digital album is easy if your family and friends can crowd around your PC screen. But what if they live hundreds or even thousands of miles away? Now you can send them a picture with an electronic mail message. Prodigy and Seattle FilmWorks have collaborated to offer a new "multimedia e-mail" feature as part of the Prodigy online network. The new service enables Prodigy members using Windows PCs to send one another photos and brief sound clips along with text.

To use multimedia e-mail, you first get your 35mm photos digitized and put onto a floppy disk using the processing service offered by Seattle FilmWorks. You then use the PhotoWorks Plus software to convert one of these digitized photos into a standard JPEG file (a common format for online pictures). Then type your message and click on the "attach" button in Prodigy's online mailbox. Choose the JPEG file you want to send and mail the message. Your recipient just clicks a button to reveal the picture.

You can also record an audio greeting to be sent as a Windows WAV file, though you must have a microphone attached to your PC to do so. (Recording software is built into Windows.) Also, recipients must have a sound card in their PCs to hear it.

The companies say they plan to expand the service to Macintosh users, and to the online world beyond Prodigy, via the Internet.—*Mark Henricks*

HANDS ON

PENTIUM TRANSPLANT

The prospect of replacing the microprocessor inside your PC can make even experienced computer users slightly squeamish. But the recent discovery of a math flaw in Intel's popular Pentium chip has prompted millions to at least consider the PC equivalent of brain surgery.

Intel eventually agreed to provide a free replacement chip to anyone who asked by calling the company (800-628-8686) or the system maker. Most Pentium chips made prior to 1995—roughly five to seven million chips—have the flaw. Yet only about 100,000 PC owners have taken advantage of the free replacement offer, according to Intel.

But aside from a mix-up about returning the old chip, I found the replacement process to be nearly painless. Intel referred me to my PC's manufacturer, Dell Computer, which handles the Pentium replacements itself. Patience was required; the replacement chip arrived a month after I called Dell to request a swap. The next day, an invoice for $794 arrived—for the old chip, in case I didn't return it. Dell called twice, but seemed mainly interested in the old chip.

Despite my trepidation, the swap itself was no problem. Once I raised the hood of my PC, a tug on the chip socket's release lever was all it took to lift the Pentium out of its base. The new chip had to be carefully aligned with a matching notch on the socket, but otherwise it was easily seated. No special tools were required. And it all worked when I was finished, which is more than I can say for some video cards and hard drives.

Still rather not mess with your microprocessor? You're probably not in any imminent danger. Intel says it has been able to confirm only two reports of computations being affected by the Pentium bug.—*Sandy Reed*

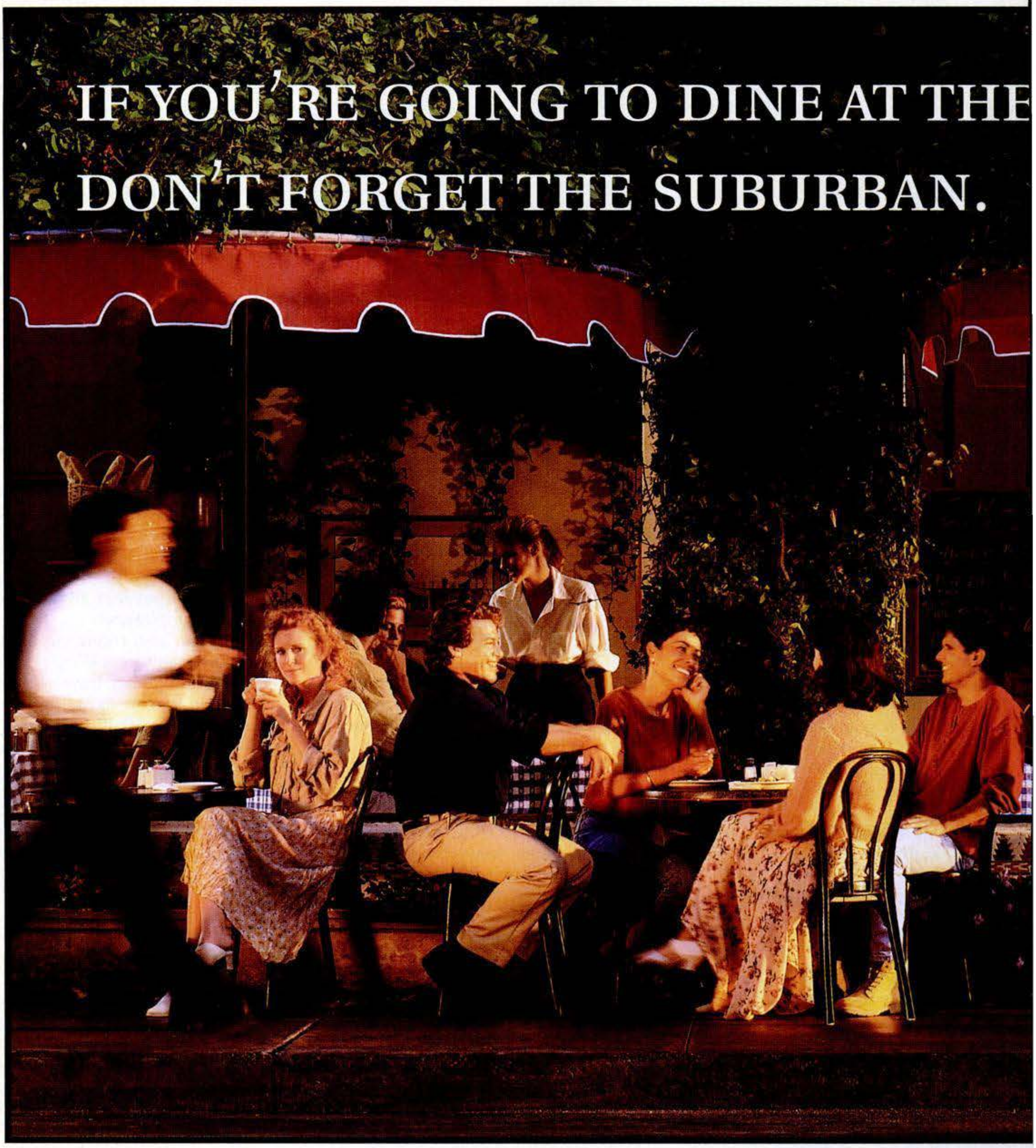
INTERNET

SAFER SHOPPING

Aside from flower delivery services and the odd food-by-mail offering, there's not much to shop for on the Internet's World Wide Web. That's partly because electronic shopping is still fraught with security problems—like the fraudulent use of credit cards.

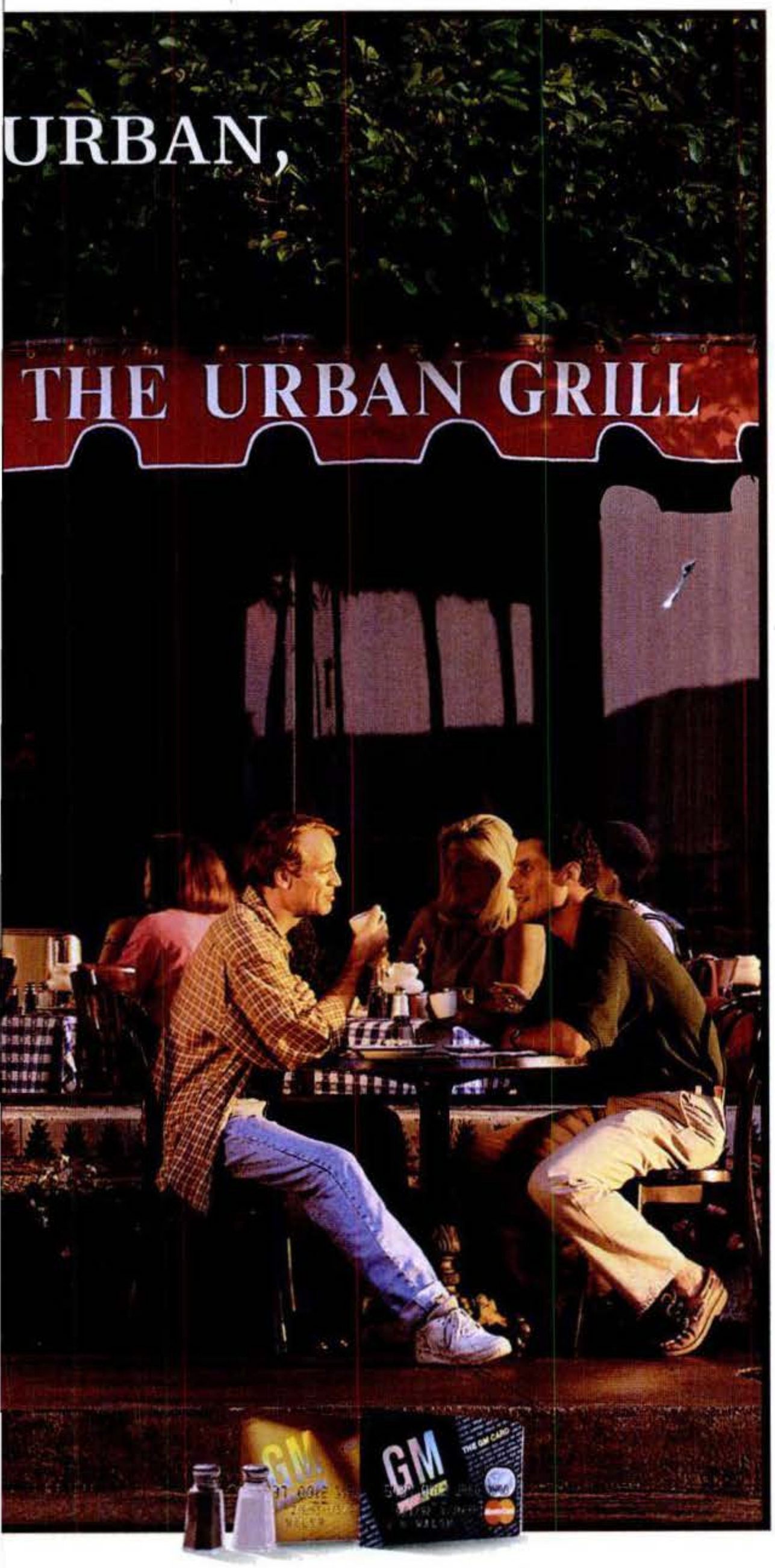
But that should begin to change with the spread of a new online security system being developed by a small company called Terisa Systems. Terisa's solution, which uses data-encryption methods to conceal credit card numbers, may be the key that unlocks Internet shopping. Its system combines the two most popular, but incompatible, online security schemes. And Terisa's efforts are being backed by all three of the major online services (America Online, CompuServe, and Prodigy), as well as several influential Internet companies.

Copyrighted material



Chevrolet • Geo • Chevy Truck • Pontiac • Oldsmobile • Buick • Cadillac • GMC Truck

Copyrighted material



You know the place.

Your favorite hangout where they know *you* by name. You get your pick of tables. Any one of the five in there. You won't find a write-up in The Restaurant Guide on it, but if you did, it would have five big plates next to it.

So whether you're going to The Urban Grill, The Beverly Hills Grill or Griff's Grill, don't forget to use your GM Card. You'll earn 5% on everything you spend toward a new GMC Suburban. Or any other GM car or truck.* The GM MasterCard® can save you hundreds, *even thousands* of

dollars, so call 1-800-9GM-CARD if you don't have one.

And leave a *big tip*. We know you will.

TODAY'S FINANCIAL VEHICLE.®

*GM Card Earnings are redeemable on purchase or lease of a new GM car or truck. Up to $500 GM Card Earnings per account year and $1,000 GM Gold Card Earnings per account year, for a maximum of $3,500/$7,000 over a seven-year period. May be combined with other GM offers. Subject to GM Card Program Rules. The GM Card® is issued by Household Bank (Nevada), N.A. ©1995 General Motors Corporation.

Copyrighted material

ONLINE

NEXT BEST THING TO BEING THERE?

Having an online conversation with another PC user traditionally meant taking turns typing words into a dark, nearly empty PC screen. But even online chatting services are getting multimedia fever.

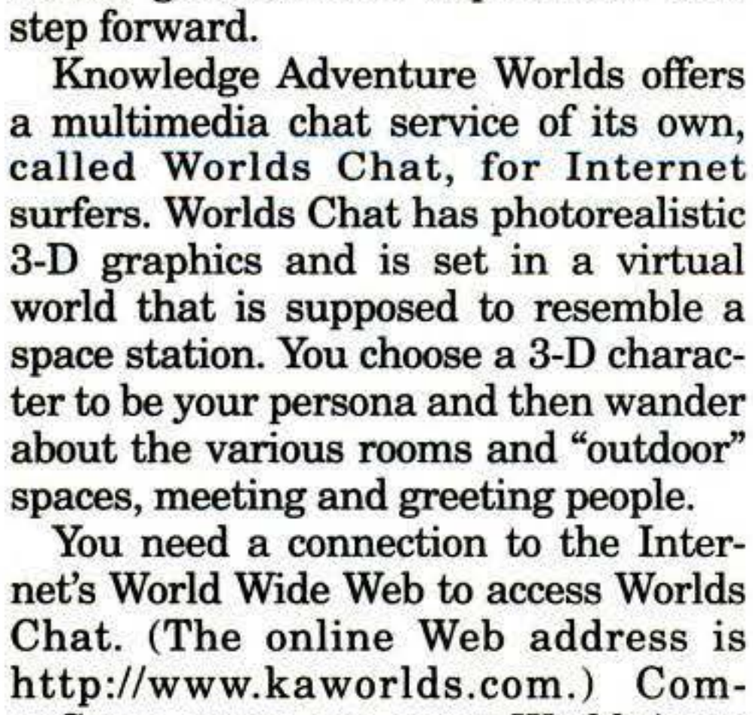
CompuServe recently unveiled a more lifelike chatting feature called WorldsAway. Chatters still converse by typing text messages into their PCs. But instead of scrolling across a blank screen, words appear inside balloons emanating from cartoon characters. Users assemble their animated likenesses—called "avatars"—from a selection of faces, body parts, and clothing. Avatars can smile, frown, sit, stand, and even go for a stroll.

Environment sounds, such as footsteps, help enliven the virtual experience. Many of the objects shown on the background displays can be picked up and even purchased with tokens earned by work at virtual "jobs."

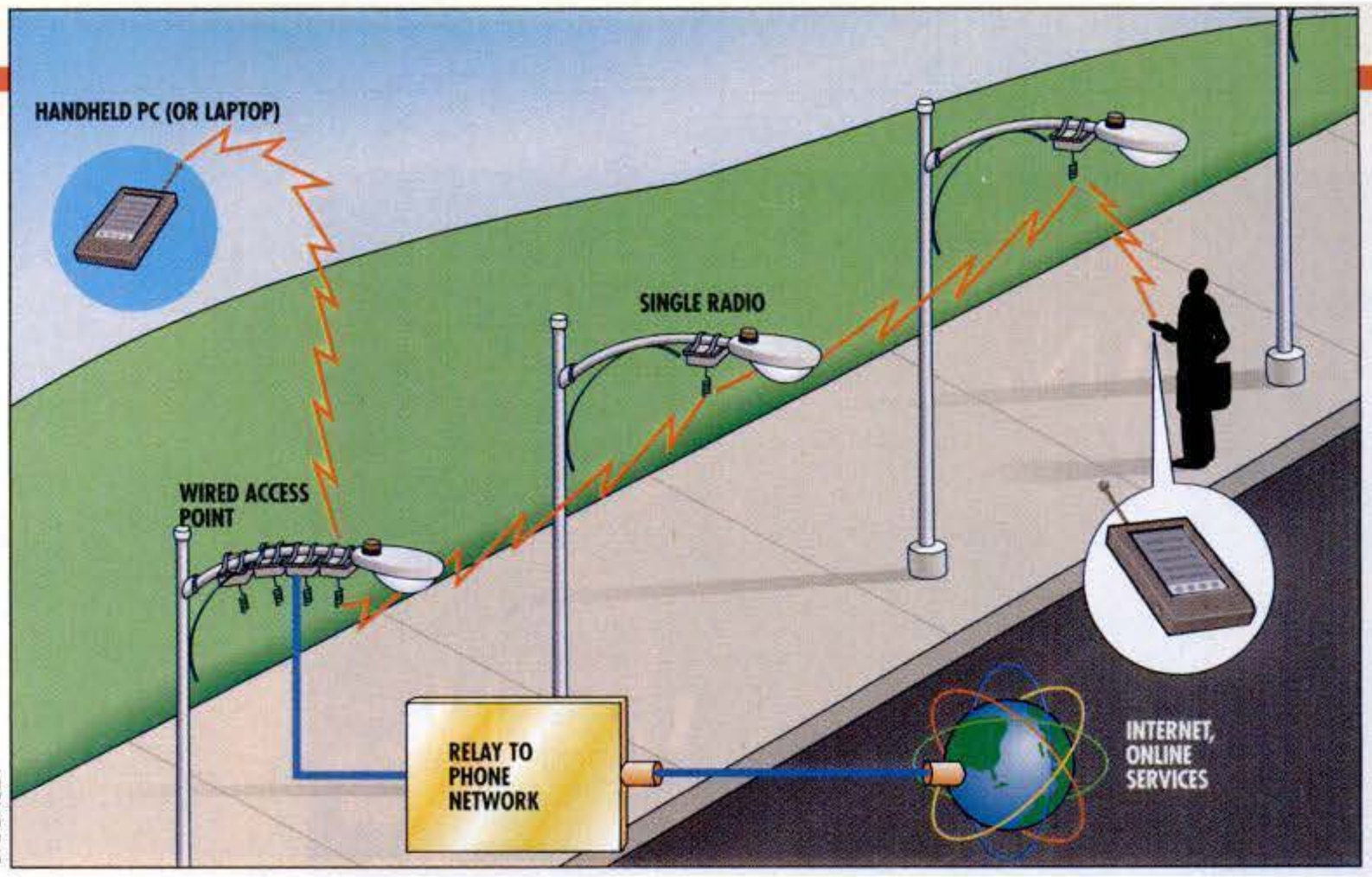
Many people still hide behind the mask of false identities. But the ability to see some representation of your counterpart and show feelings through visible gestures and expressions is a step forward.

Knowledge Adventure Worlds offers a multimedia chat service of its own, called Worlds Chat, for Internet surfers. Worlds Chat has photorealistic 3-D graphics and is set in a virtual world that is supposed to resemble a space station. You choose a 3-D character to be your persona and then wander about the various rooms and "outdoor" spaces, meeting and greeting people.

You need a connection to the Internet's World Wide Web to access Worlds Chat. (The online Web address is http://www.kaworlds.com.) CompuServe users can enter WorldsAway by typing "Go Away."—*M. H.*


WorldsAway
File Options Window Help
How have you been, Paula? Did you get my letter?
No, I haven't checked my mail folder yet.
I've been so busy!

CompuServe's new WorldsAway service lets you adopt a cartoonlike persona while chatting.



The Ricochet network uses radio transmitter-receivers mounted on street lights and utility poles to relay wireless signals between portable PCs and online services.

COMMUNICATION

LIGHTPOLE LINKS

A new type of wireless PC network is taking shape in a portion of the radio frequency spectrum normally reserved for garage door openers and car alarms—and with signals that travel atop pedestrian fixtures like street lights and utility poles.

Called Ricochet, the wireless network forgoes the usual system of separate radio towers. Instead, it transmits signals through shoebox-sized radios that are mounted on pole tops from one-quarter to one mile apart. For each 100 to 120 pole tops, Metricom builds a "wired access point" in the form of a cluster of radios that are tied into the phone network, allowing communication with the wired world. Small, battery-powered modems enable you to connect a laptop or handheld PC with company networks, the Internet, and online services like America Online and CompuServe.

The Ricochet network is being rolled out gradually by Metricom, a ten-year-old Los Gatos, Calif., company. Metricom began selling modems and access to its public wireless network last November in the San Francisco area. Next on the list for expansion are Boston, the Redmond-Bellevue area of Washington state, and Austin, Texas.

Because the network operates in the 902- to 928MHz license-free band, it costs less than existing wireless services such as Ardis and RAM Mobile Data. Metricom offers several flat-fee plans that give you unlimited access to the network for $30 to $50 per month. Modems cost $299 with a year's subscription, or $600 separately. Ricochet modems work with standard communications software, and the network has a top speed of about 100,000bps, compared to 19,200bps for RAM or Ardis, which are nationwide services.

Metricom has to share its slice of the radio pie, but the company claims that isn't a problem because the spectrum is so large and because its radios change channels every 25 milliseconds using a frequency-hopping system.—*S. R.*

CD-ROM

SUPER DISCS

Today's CD-ROMs hold up to 700MB of words, pictures, and sounds—yet even that's not room enough for applications like huge databases and sophisticated animation. But thanks to research aimed at developing digital video discs, next year may bring a second generation of CD-ROMs capable of storing several thousand megabytes, or gigabytes (GB), of information.

The new CD-ROMs will likely use one of the two digital video disc formats currently being proposed [see Electronics Newsfront, Apr.]. The two-sided disc backed by Toshiba and Time Warner holds 10GB (5GB per side), while the single-sided disc from Sony and Philips holds 7.4GB. Despite its lower capacity, the single-sided format may be a better medium for CD-ROM titles since PC users wouldn't have to flip the disc over and publishers wouldn't have to break software into halves.

You'd need a new CD-ROM reader to take advantage of either format, but any high-capacity reader should be able to play existing titles. Among the earliest programs expected to take advantage of the extra space would be CD-ROM phone directories, encyclopedias, and games.—*Hal Glatzer*

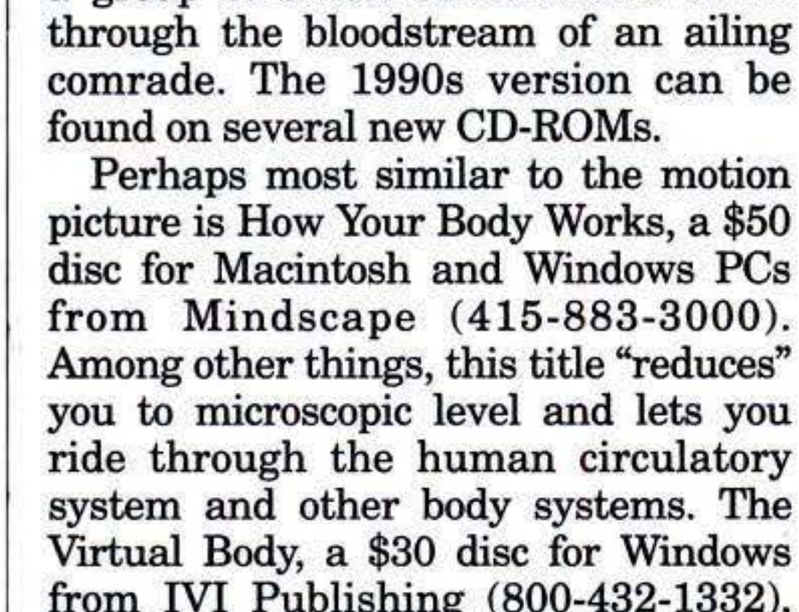
Copyrighted material

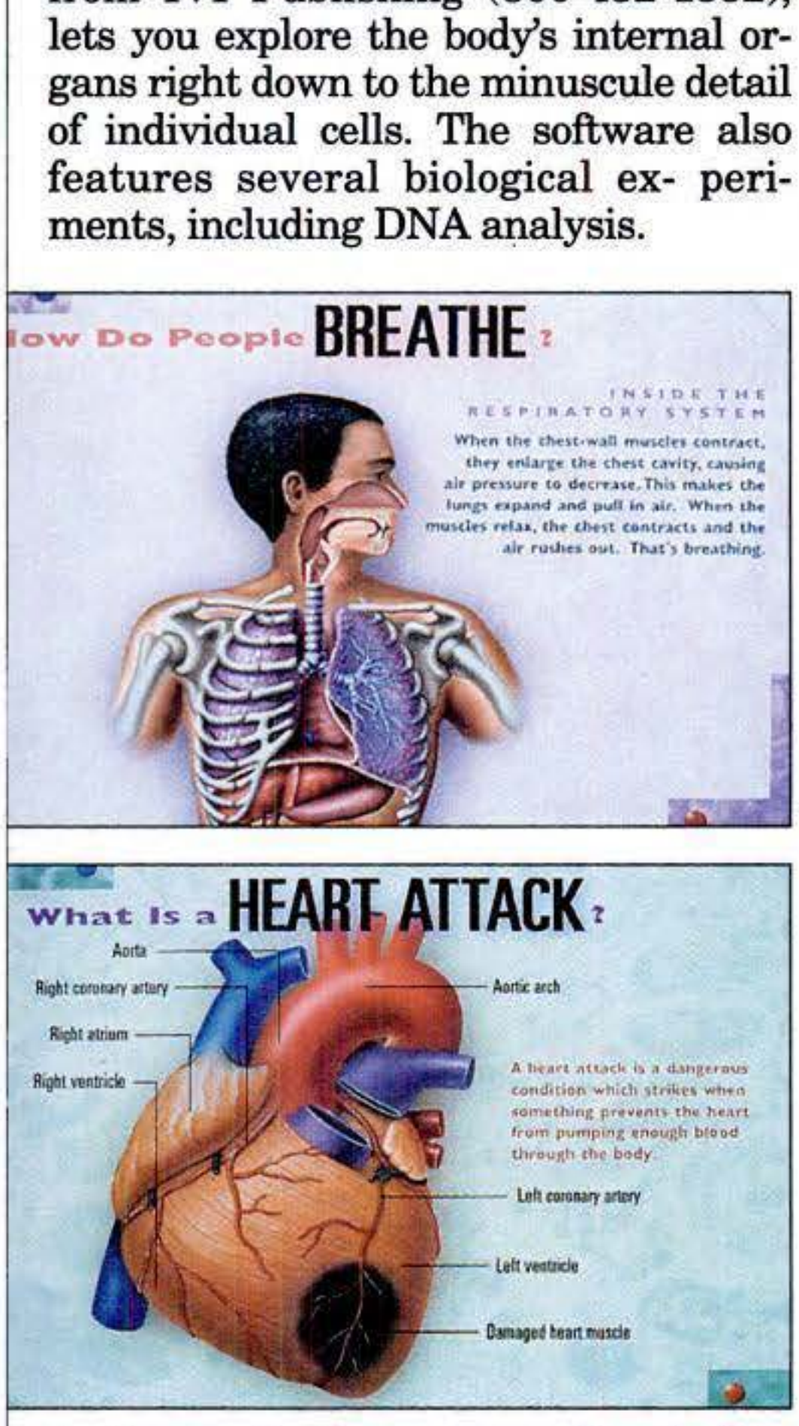
EDUTAINMENT

BODY SURFING

One of the staples of TV's late-late movie rotations is the 1960s kitsch classic *Fantastic Voyage*, in which a group of shrunken scientists travel through the bloodstream of an ailing comrade. The 1990s version can be found on several new CD-ROMs.

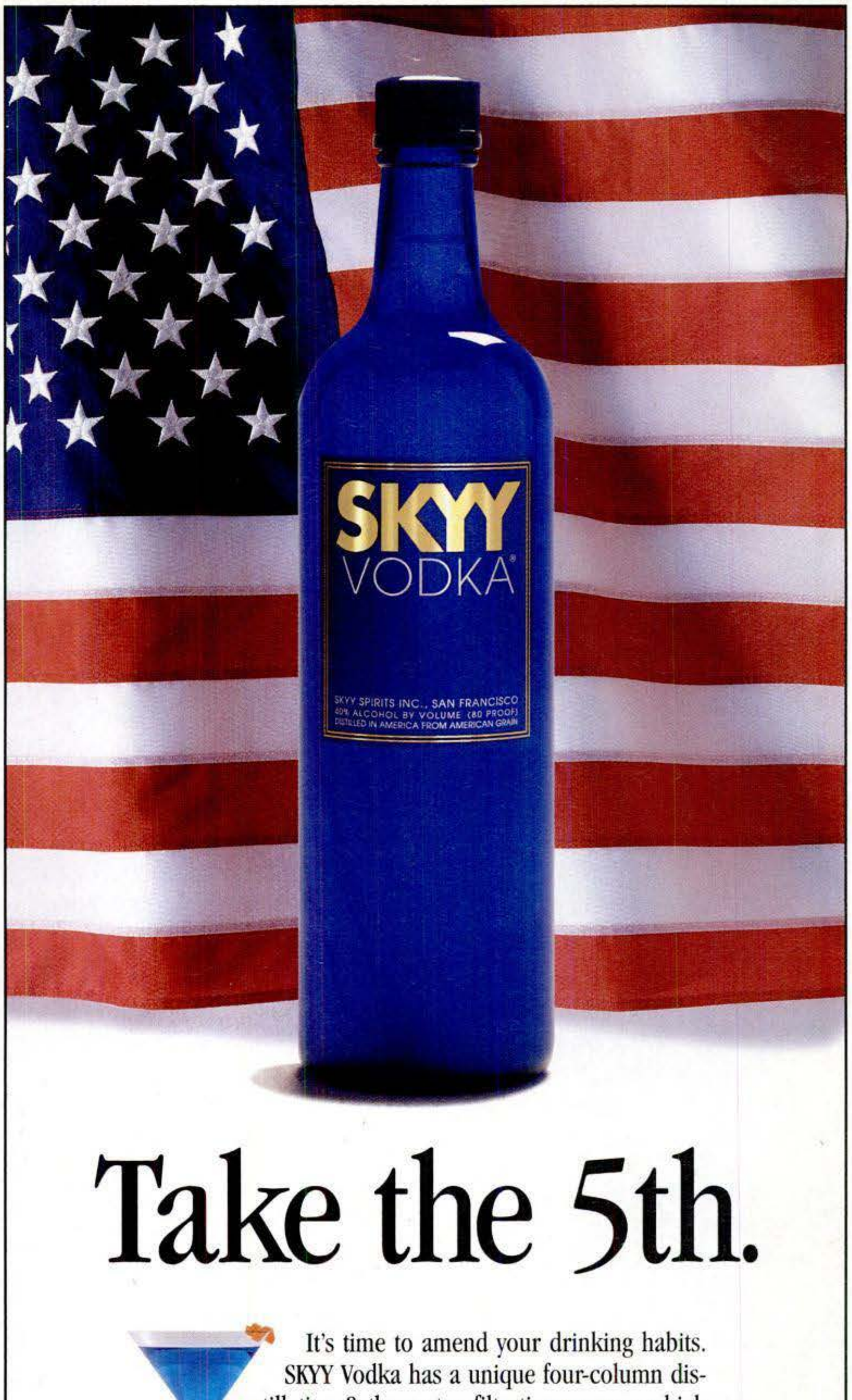
Perhaps most similar to the motion picture is How Your Body Works, a $50 disc for Macintosh and Windows PCs from Mindscape (415-883-3000). Among other things, this title "reduces" you to microscopic level and lets you ride through the human circulatory system and other body systems. The Virtual Body, a $30 disc for Windows from IVI Publishing (800-432-1332), lets you explore the body's internal organs right down to the minuscule detail of individual cells. The software also features several biological ex- periments, including DNA analysis.


How Do People BREATHE?
INSIDE THE RESPIRATORY SYSTEM
When the chest-wall muscles contract, they enlarge the chest cavity, causing air pressure to decrease. This makes the lungs expand and pull in air. When the muscles relax, the chest contracts and the air rushes out. That's breathing.


What Is a HEART ATTACK?
Aorta
Right coronary artery
Right atrium
Right ventricle
Aortic arch
A heart attack is a dangerous condition which strikes when something prevents the heart from pumping enough blood through the body.
Left coronary artery
Left ventricle
Damaged heart muscle

Anatomy-exploration programs such as The Virtual Body let you get an inside look at how the human body works—without medical training and the accompanying blood stains.

And the choices in anatomy adventures keep growing. A.D.A.M. Software (800-755-2326), which sells professional-level medical titles, now has a consumer version of its body-explorer software called A.D.A.M. The Inside Story. It lists for $40 and works on both Macs and Windows PCs. The Ultimate Human Body, a $50 Windows title from Doring Kindersley Multimedia (800-225-3362), enables you to explore how body functions interact.—*Jeff Hecox* PS



Take the 5th.

It's time to amend your drinking habits. SKYY Vodka has a unique four-column distillation & three-step filtration process which ensures exceptional quality and an unmistakably clean taste. We're not allowed to tell you how this affects your constitution, so even though we have to take the fifth, you're very welcome to buy it.

SKYY VODKA®
The Intelligent Drink.

Try a BlueSKYY Martini, made with SKYY Vodka, a splash of Blue Curacao and a twist of orange.

DISTILLED IN AMERICA FROM AMERICAN GRAIN

40% ALC/VOL (80 PROOF). 100% GRAIN NEUTRAL SPIRITS. ©1995 SKYY SPIRITS, INC. SAN FRANCISCO, CA. BE RESPONSIBLE. DON'T DRINK AND DRIVE.

Copyrighted material

CRISIS *in* SPACE

The Heroic Flight Of Apollo 13

When a massive explosion disabled this lunar mission, NASA proved it had the righ

Monday evening, April 13, 1970. TV viewers across America watched prime-time fare like the *Doris Day Show* and NBC's *Monday Night at the Movies.* None saw the live telecast from the cabin of the moon-ward-bound Apollo 13—because the networks didn't carry it. Only nine months since Neil Armstrong and Buzz Aldrin's "giant leap for mankind," the Apollo moon missions already seemed to have lost some of their magic. Only Americans, perhaps, could become jaded about trips to another world.

Or perhaps it was an inevitable consequence of success. With Apollo 11's triumph in July 1969, the United States had won the "space race" with the Soviet Union and fulfilled the late John F. Kennedy's goal of a manned lunar landing by the end of the decade. By the time of Apollo 12's flawless lunar touchdown in November, the public was already losing interest.

And so, on this Monday evening, the main audience for Apollo 13's TV show was a team of flight controllers at NASA's Manned Spacecraft Center near Houston. For these men, near the end of an eight-hour shift in mission control, the chance to see the astronauts give a guided tour of their craft was a pleasant diversion from the slowest time of the mission: With less than a day to go until Apollo 13 reached the moon, and everything going according to plan, there was so little to do that earlier, Capcom Joe Kerwin had quipped to the astronauts, "We're bored to tears down here." No one knew that Apollo 13 was a time bomb about to explode, and that a life-and-death struggle

---

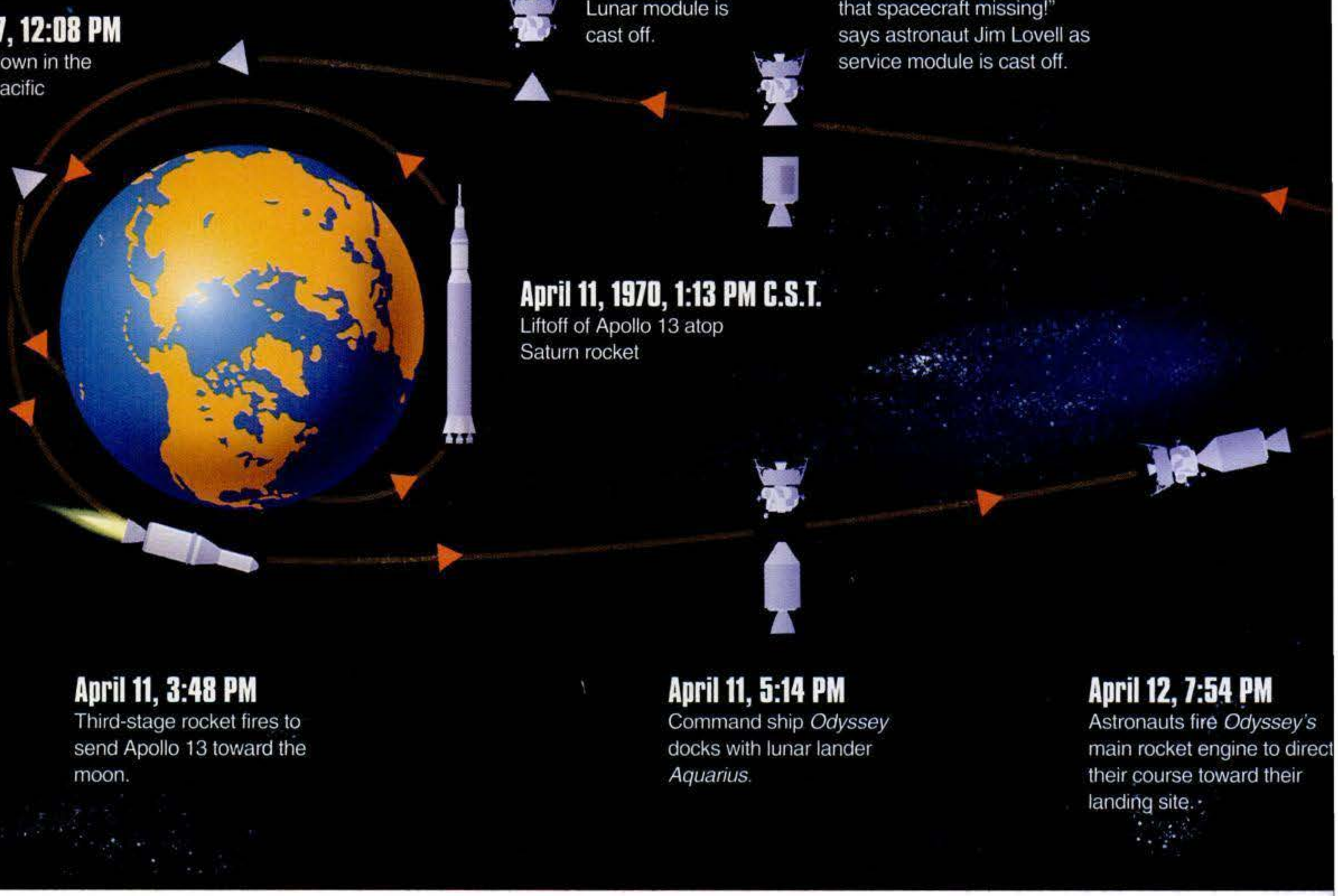
Based on *A Man on the Moon: The Voyages of the Apollo Astronauts,* by Andrew Chaikin (Penguin, 1995)

Copyrighted Material

tuff to rescue the crew. BY ANDREW CHAIKIN

Copyrighted material

"HOUSTON, WE'VE HAD A PROBLEM"


April 17, 12:08 PM
Splashdown in the South Pacific
April 17, 10:43 AM
"Farewell, *Aquarius*." Lunar module is cast off.
April 17, 7:15 AM
"There's one whole side of that spacecraft missing!" says astronaut Jim Lovell as service module is cast off.
April 11, 1970, 1:13 PM C.S.T.
Liftoff of Apollo 13 atop Saturn rocket
April 11, 3:48 PM
Third-stage rocket fires to send Apollo 13 toward the moon.
April 11, 5:14 PM
Command ship *Odyssey* docks with lunar lander *Aquarius*.
April 12, 7:54 PM
Astronauts fire *Odyssey's* main rocket engine to direct their course toward their landing site.

was about to begin.

Just now, a few minutes before 9 p.m., Houston time, the monitors in mission control showed the face of Apollo 13's commander, Jim Lovell. At age 42, he was the most experienced astronaut alive; Apollo 13 was his fourth space mission and his second lunar voyage. As navigator on the Apollo 8 flight in December 1968, he'd become one of the first three men to circle the moon. Looking down at its desolate expanse from a height of 69 miles, Lovell had wanted nothing more than to land on that alien ground. And there was something else he wanted: his own crew. Now, as commander of history's third lunar-landing mission, he would have both. If the world took little notice of Apollo 13, that did not concern him. This flight would be the pinnacle of his career and the first devoted entirely to scientific exploration of the moon. Lovell and his rookie lunar module pilot, Fred Haise, who had spent weeks training with professional geologists, would make their mark not only as test pilots but as lunar explorers, in the moon's Fra Mauro highlands. The mission patch, which Lovell had helped to design, read *Ex Luna, Scientia*—From the moon, knowledge.

By 9:08 p.m., the telecast was over. Inside *Odyssey,* the joined command and service modules, Lovell waited for Haise to close up the lunar module *Aquarius* for the night. Meanwhile, in the command module's left-hand couch, Jack Swigert tended to a request from mission control to activate fans in *Odyssey's* two liquid oxygen tanks, housed in the cylindrical service module, which was attached to the base of the cone-shaped command module. In zero gravity, the super-cold liquids tended to become stratified, making it difficult for the astronauts and flight controllers in Houston to get accurate quantity readings. The fans solved the problem by stirring up the contents like an eggbeater. Swigert turned the fans on briefly, then turned them off. Moments later the men heard a loud, dull bang.

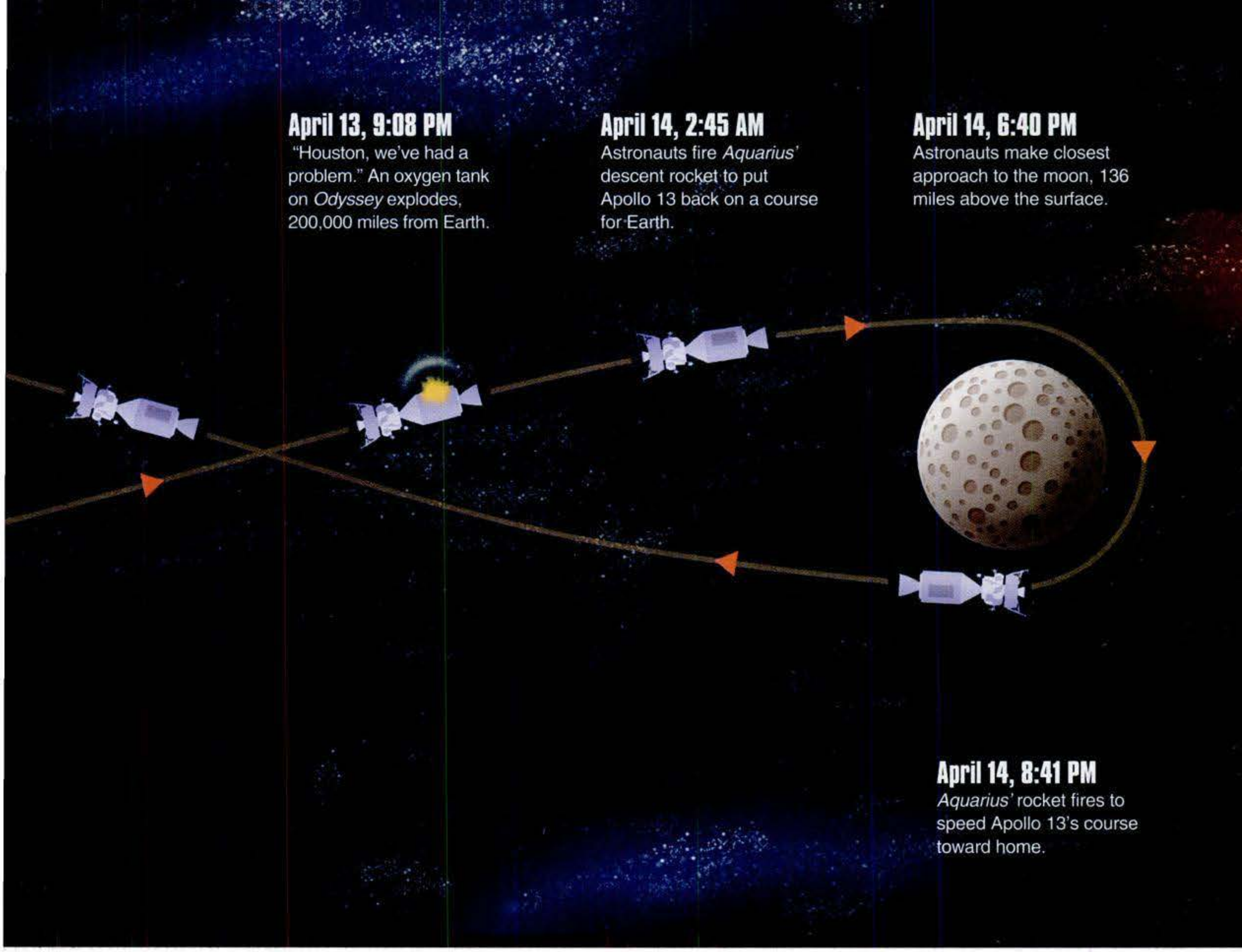
At first, Lovell thought Haise had activated the lander's noisy repressurization valve; Haise enjoyed scaring his crewmates half to death with it. But Haise hadn't touched the valve, and when Lovell looked at Jack Swigert, the rookie command module pilot's eyes were wide with alarm. Strapped into his couch, Swigert had felt the spacecraft shudder. Suddenly, an alarm signal rang in their headsets. On the instrument panel, warning lights glowed red. There was a problem with *Odyssey's* electrical system; one of the two main electrical junctions, or buses, was not delivering enough voltage. "OK Houston," Swigert radioed, "we've had a problem."

"This is Houston," said Capcom Jack Lousma. "Say again, please."

Lovell, now in the center couch, keyed his mike: "Houston, we've had a problem. We've had a MAIN B BUS UNDERVOLT."

Fred Haise, meanwhile, left *Aquarius* and hurried back to *Odyssey*. Floating through the connecting tunnel between the two craft, he heard sounds of metal flexing as the joined ships rocked back and forth against one another. Something had jolted Apollo 13. Lovell and Swigert suspected a micrometeorite had struck the lander, and as Haise returned they scurried to install the command mod-

Copyrighted material


April 13, 9:08 PM
"Houston, we've had a problem." An oxygen tank on *Odyssey* explodes, 200,000 miles from Earth.
April 14, 2:45 AM
Astronauts fire *Aquarius'* descent rocket to put Apollo 13 back on a course for Earth.
April 14, 6:40 PM
Astronauts make closest approach to the moon, 136 miles above the surface.
April 14, 8:41 PM
Aquarius' rocket fires to speed Apollo 13's course toward home.

ule's forward hatch, thinking there might be an air leak. But the hatch would not seal; in their haste, they had misaligned it. Suddenly they realized there was no air leak; nothing was wrong with *Aquarius.* But Haise, now scanning the instruments from the command module's right-hand seat, saw that something was very wrong with *Odyssey*. One of the craft's three power-producing fuel cells, which combined oxygen and hydrogen to produce current, was dead.

At that moment, each man knew the awful truth: The mission was over. Without all three fuel cells working, the men were forbidden even to go into lunar orbit. Lovell's heart sank as he realized he wasn't going to land on the moon.

But there was no time for regret as the crisis deepened. More warning lights came on; another fuel cell had died. Swigert, meanwhile, tried unsuccessfully to stabilize the spacecraft—which had been slowly tumbling since the bang—using the service module's maneuvering thrusters. He wondered if some of them weren't working. And Jim Lovell saw alarming readings for *Odyssey*'s two oxygen tanks: Minutes ago they had both been full; now tank number 2 was completely empty, and tank number 1 was down to a third of normal and still dropping. Even the command module's onboard computer had been momentarily disrupted by the bang.

In practice sessions on Earth, Lovell and his crew had been hit with all kinds of simulated emergencies. But not even the most diabolical training instructors had dealt out so many seemingly unrelated failures at once. If they had, the astronauts would have said, "Come on, you're not being realistic." The spacecraft was designed with so many redundant components that this particular combination of glitches was unthinkable. No one would have imagined the emergency developing aboard Apollo 13.

In mission control, flight director Gene Kranz, whose rugged, crew-cut appearance and no-nonsense manner had won him the nickname "General Savage," presided over his White Team of controllers and wondered what was happening. Kranz was a veteran of manned spaceflight going all the way back to Mercury. He'd seen his share of emergencies, and he'd seen what these young flight controllers, most of whom were in their mid-twenties, could do. They were so sharp, so savvy, and so well trained that they could solve almost any problem, sometimes in a matter of seconds.

But this wasn't like past missions. In a spacecraft whose every component was thought to be at least 99.9 percent reliable, everyone believed, any mishap that could knock out two oxygen tanks and two fuel cells would surely have killed the crew. Could all of this be nothing more than a false alarm caused by faulty instrumentation? The controllers thought so, and Kranz hoped they'd figure out a way to work around this glitch and continue with the mission.

But now, 14 minutes after the astronauts' first report of trouble, there was a chilling report from Jim Lovell, in a deceptively calm voice: "We're venting something into space. It appears to be a gas of some sort." At that moment, Kranz realized the emergency was real.

Copyrighted material

NASA

Shoulder to shoulder in their lunar module lifeboat, Jim Lovell, Jack Swigert, and Fred Haise ride out the long, cold trip home (above).

When carbon dioxide buildup threatened the astronauts, controllers devised a makeshift air purifier, held here by Deke Slayton in mission control (right).

Three of the heroes of Apollo 13, flight directors Gerry Griffin, Gene Kranz, and Glynn Lunney (from left to right), exult in mission control at the astronauts' safe return (below).

For the astronauts, it didn't take long to understand that the gas was oxygen spilling from the service module's tanks, and that it was only a matter of time before the tanks would empty. In Houston, Kranz and his team were struggling to avert that outcome. If they failed, the entire command ship, designed to carry the astronauts from and to Earth, would be dead.

Inside *Odyssey*, Lovell and his crew faced their grim situation. The disappointment of losing the mission had paled before the realization that they were in danger of dying. They were 200,000 miles from Earth and getting farther away every second. Normally, they might have tried to fire *Odyssey*'s main rocket engine to execute a U-turn and head directly back to Earth. But that engine might have been damaged; with no way to inspect the service module, they couldn't tell. And even if it hadn't, it would soon be out of commission, along with the rest of the command ship.

Providentially, the Apollo 13 crew had the ultimate backup: another spacecraft. The lunar module, with its oxygen, electrical power, and rocket engines, would have to function as their lifeboat on a long voyage home.

That wasn't going to be easy. Without *Odyssey*'s powerful main engine, the only option was to loop around the moon, using its gravitational pull to bend Apollo 13's path until it was heading back to Earth. This so-called "free-return" trajectory was a built-in safety measure on all lunar flights. But Apollo 13 was no longer on the free return. A day earlier, the astronauts had fired the service module's engine to steer onto a different path, one that would reach their landing site at Fra Mauro. Unless they used *Aquarius*' descent rocket to get back on the free return, they would miss Earth by 3,000 miles, and Apollo 13 would orbit in the void forever. Lovell told himself that *Odyssey* must reach Earth at all costs, even if he and his crew didn't survive. Better to burn up in the atmosphere, he thought, than to end as a permanent memorial to the space program.

More than 90 minutes had passed since the bang, and in mission control flight director Glynn Lunney and his Black Team—the next shift—had taken over. Already, they had directed Jack Swigert to begin shutting down some of *Odyssey*'s systems to save power; now it was clear that it was beyond saving. Meanwhile, Lunney's lunar module experts worked feverishly to assemble procedures to guide Lovell and Haise in activating *Aquarius* as swiftly as possible. There was no time to lose. The dwindling supply in *Odyssey*'s remaining oxygen tank allowed for only 15 more minutes of power. Once it was gone, the command module would have only a set of small batteries for power and a small oxygen tank for breathing. But these had to be saved for reentry into Earth's atmosphere. Over the communications loop, Lunney spurred his controllers to work fast. And in space, Lovell and Haise left Swigert alone in *Odyssey* and headed for *Aquarius*.

By midnight the lander was activated and Swigert had shut down the last of *Odyssey*'s systems. With his ship now dark and lifeless, Swigert went to join his crewmates. They paused in their work long enough to see him floating into the lander's tiny cabin, looking forlorn. He told Lovell

Copyrighted material

and Haise, "It's up to you now."

For the next two and a half hours, Lovell and Haise made preparations to fire *Aquarius'* descent rocket. They knew the free-return maneuver had to be executed precisely, but when Jim Lovell tried to orient the joined spacecraft, the task proved surprisingly difficult. The reason was *Odyssey*: Its 32-ton mass, docked to the lander's ceiling, offset the center of gravity. When Lovell nudged the hand controllers, the craft wobbled strangely. It was like learning to fly all over again. Finally, at 2:42 a.m., all was ready. Lovell and Haise lit the engine in a 31-second blast that put them right on the free return. A second rocket burn, after they rounded the moon, would shorten their homeward journey. For the first time, the men let themselves believe they would make it back to Earth. But their ordeal was far from over.

It was well past midnight on Tuesday, April 14, but the Manned Spacecraft Center was buzzing with activity. Office lights glowed all across the campuslike expanse of buildings. Mission control was crowded with off-duty flight controllers adding their brain power to the rescue effort. In the control center's back rooms, Gene Kranz had organized his team and other Apollo personnel into groups to attack a host of daunting problems. Foremost was figuring out a way to stretch *Aquarius'* supplies to last the return voyage. The lander had been designed to keep two men alive for 45 hours, time enough for Lovell and Haise to land on the moon, make two moonwalks, and rejoin Swigert in lunar orbit. Now it would have to support all three men for anywhere from 77 to 100 hours, depending on what kind of rocket firing the astronauts made. Would it be up to the task?

They weren't the only ones asking that question. On Long Island, at the Grumman Corp.'s plant in Bethpage, hundreds of men and women who designed, built, and tested the lunar module sought an answer. And aboard *Aquarius,* Fred Haise had time to make his own assessment. Haise, who had spent more hours than he could count in lunar modules during tests on Earth, dug into his data books and began calculating. He didn't worry about oxygen for breathing; the lander's supply, along with the oxygen in the space suit backpacks, was more than enough. The critical item was electrical power. The lander's batteries (it had no fuel cells) were good for about two days of normal operations. By turning off most of *Aquarius'* systems, Haise figured, he and Lovell could stretch the power supply to four days. But cooling water was a major problem; it was essential to keep the craft's electronic gear from overheating. With careful rationing, Haise calculated, *Aquarius'* supply would barely be enough. If nothing else went wrong on this flight, they would probably make it home.

On Earth, the lunar module experts independently reached a similar conclusion. But there was nothing in their data books that could predict how well the astronauts themselves would hold up. By now the men were in great need of sleep, and they agreed to take turns. Sometime past 9 a.m., Haise headed for the command module to sleep, leaving his crewmates to stand watch in *Aquarius.*

Through the lander's two triangular windows, the moon was now a gray,

LIGHTS, CAMERA, LIFTOFF!

© UNIVERSAL CITY STUDIOS, INC.

Ron Howard directs Tom Hanks as Jim Lovell inside one of the meticulous mock-ups for the sets of the Universal Studios movie *Apollo 13*.

When director Ron Howard wanted to bring *Apollo 13* to the big screen for Universal, he needed sets that were literally out of this world. Views of Earth and the moon would be handled by special-effects wizards with sophisticated computer graphics. But the most important sets of all, *Odyssey* and *Aquarius,* would have to be physically recreated.

Howard turned to the king of space hardware: Max Ary, director of the Kansas Cosmosphere and Space Center in Hutchinson. Ary's museum contains real space hardware and masterly recreations produced by the Cosmosphere's Space Works division. After getting the go-ahead from Howard in June 1994, Space Works craftspeople had only four months to produce complete mock-ups of the command module and lunar module interiors, along with realistic space suit costumes for the actors.

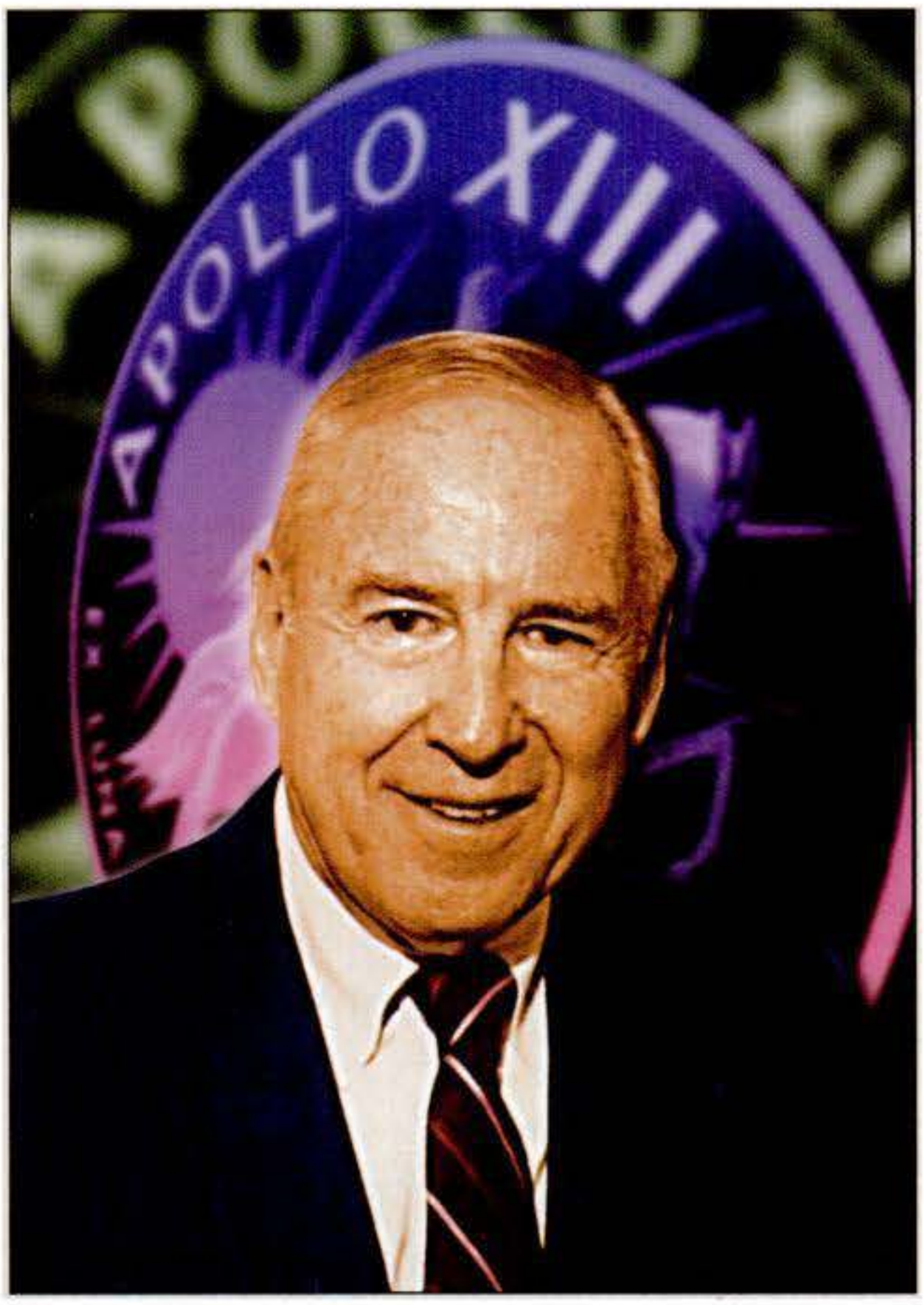
"Ron Howard wanted everything to be as accurate as possible," says Ary. To mimic everything down to the last dial, label, and control, Ary's people studied real Apollo hardware in their collections. They even incorporated a few pieces of the real Apollo 13 command module—whose components had been disassembled after the mission—into the sets.

Space Works' task was made even more daunting by Howard's desire to photograph his actors from all possible angles. As Ary explains, "This movie was shot almost entirely in two tiny spacecraft. How many ways can you show it and make it interesting?" The solution was to build the cabins in pieces, any one of which could be removed to give access to cameras.

As if that weren't enough, *Apollo 13* was the first commercial film to include footage taken aboard NASA's KC-135 weightlessness training aircraft, otherwise known as the Vomit Comet. New sets had to be built to fit within the cabin of the converted cargo plane, and they had to withstand the rigors of filming as cast and crew were subjected to alternating periods of zero-gravity and twice normal gravity. By the time the filming was done, the make-believe spacecraft cabins sustained far more wear-and-tear than their real counterparts. "We just about cried when we saw them," says Ary. Space Works went right to work patching them up for display at Universal's theme park in Florida.—*A. C.*

Copyrighted material

AN ASTRONAUT RECALLS



Jim Lovell as he appears today. The Apollo 13 patch in the background says, in Latin, "From the moon, knowledge."

If you ask Jim Lovell how he's doing, he sometimes answers, "Great. I'm still alive." He explains, "I'm living on borrowed time. My life could have ended on April 13th, 1970."

Today the 67-year-old Lovell looks back on his mission with a mixture of pride and wistfulness.

"I'm disappointed that we didn't get to land on the moon," he says, but adds that if he had to do it all over again, he would still want Apollo 13 on his spaceflight resume. For Lovell, who was a Navy test pilot before he came to NASA, Apollo 13 gave him a chance to show his skill in meeting the unexpected.

"To show the depth of your expertise, to bring back an almost catastrophic situation," he says, "is the real test of a test pilot."

Lovell is getting new recognition these days, thanks to Ron Howard's Universal movie, *Apollo 13*. Lovell even has a cameo in the new film: He plays the captain of the Apollo 13 recovery ship *Iwo Jima*.

For Fred Haise, it's been more difficult to put a good face on Apollo 13, which was his only spaceflight. Getting back to Earth, he says, was "a remarkable recovery from a bad situation." But he can't overlook the flight's missed objectives. "Our mission was a failure," he says. "No way around it." He left NASA in 1977.

Today he is president of Grumman Technical Services in Titusville, Fla.

Perhaps the most surprising views come from Ken Mattingly, who lost his seat on Apollo 13 because of a nonexistent case of German measles and went on to orbit the moon during the Apollo 16 flight. If people think he's glad to have missed out on Apollo 13's misfortune, they're wrong. "I have personally prospered by not being onboard," Mattingly says. "But I wish I had been." It's precisely because the mission turned out to be an ordeal that Mattingly says,"I feel somehow like I didn't do my share." He adds, "Does that make any sense? Hell, no."

Jack Swigert, who went in Mattingly's place, died of lung cancer on December 27, 1982.—*A.C.*

pockmarked ball, close enough for Lovell and Swigert to see craters with the unaided eye. For Swigert, the events of the last few hours were especially ironic: He'd only joined the crew of Apollo 13 a day before launch, after NASA doctors found out that prime crewman Ken Mattingly had been exposed to German measles and might get sick during the mission. Now Mattingly, who had trained intensively for nine months to go to the moon, was an Earthbound witness to his crewmates' ordeal. And Swigert was nearly 240,000 miles from home, a man without a spacecraft. He knew that *Aquarius,* designed solely for the airless void of space, could not take him and his crewmates all the way home; only *Odyssey*, with its heat shield, could handle the fiery reentry into Earth's atmosphere. He also knew that the command module wasn't designed to be shut down, exposed to the chill of space for several days, and then reactivated. When the time came, would it work?

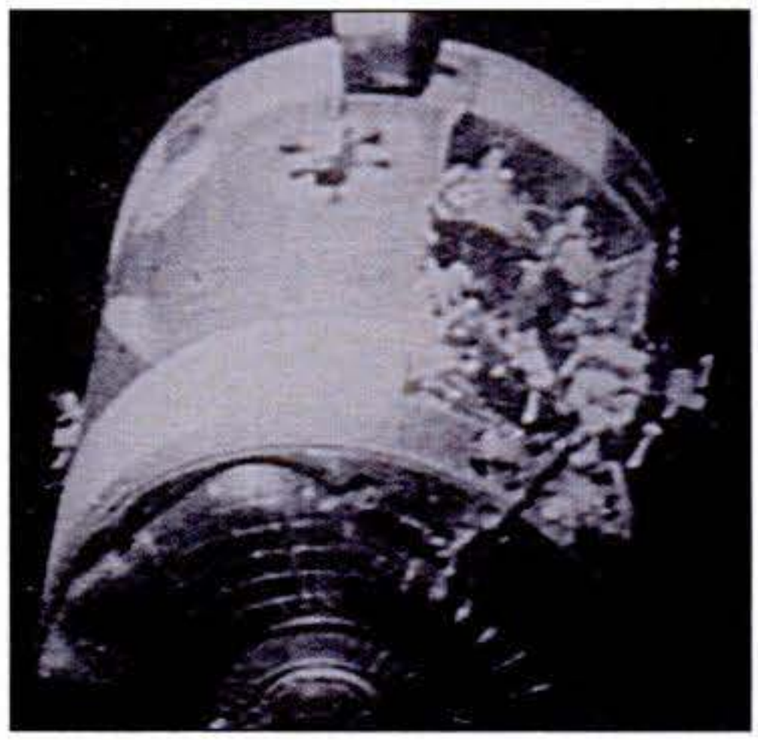
In the meantime, Swigert's thoughts focused on the checklist he would need to revive *Odyssey*. It would have to be carefully scripted, down to the last switch. Normally it took months to write and test such procedures, but mission control would have to do it in a matter of days. One thing was certain: There would be no postponing reentry.

In mission control, where the radio transmissions from *Aquarius* were often marred by static, listeners nevertheless managed to hear Swigert's musings, thanks to an inadvertently set mike switch. And they heard Jim Lovell tell his rookie crewman, "Well, I'm afraid this is going to be the last lunar mission for some time." NASA administrator Tom Paine assured the press that the agency had every intention of going back to the moon, once they had figured out what went wrong and how to keep it from happening again.

Around the world, the voices of the three astronauts in peril were heard by millions of people who anxiously followed this cliffhanger. Prayers were said in the Vatican, at a gathering of 100,000 in India, and at the Wailing Wall in Jerusalem. Not since the first moon landing had so many people paused in their daily lives to follow a spaceflight. Apollo 13, which Jim Lovell had thought would be a historical footnote, was anything but.

By Tuesday afternoon, anticipation was building for the day's most important event: the rocket firing that would take place two hours after Apollo 13's *pericynthion*, or closest approach to the moon. The so-called PC+2 burn would trim a full day off the return trip, conserving the lander's precious supplies of power and water. But the accuracy of the maneuver would depend on *Aquarius*' guidance system, and controllers worried it might be drifting out of alignment. Normally, the astronauts could have checked it by sighting on stars using

[Continued on page 86]



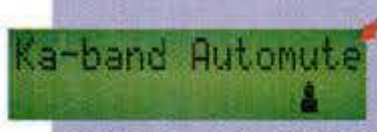
"There's one whole side of that spacecraft missing!" A gaping hole in Apollo 13's service module reveals the scars from the near catastrophic explosion of oxygen tank number 2.

Copyrighted material

THE WORLD'S FIRST LCD DETECTOR!

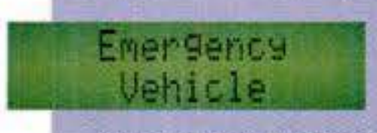
Passport 5000's Total Picture™ technology uses an LCD panel to provide continual updates on radar, laser, detector status modes and driving conditions in your area.

You are receiving more than one X-band signal.



The alert audio has been automatically muted.

You are reminded that "City" mode is selected.



An emergency vehicle is near.

A potential road hazard is near.

You have muted the audio.

A false signal is being automatically rejected.

K-band radar is being used nearby.

Total Picture™ technology uses 1120 pixels to visually display information in easy-to-understand terms. Other detectors can typically devote only 11 LEDs to information display.

NO-HASSLE GUARANTEE:
Try Passport 5000 for 30 days. If you're not satisfied, return it for a refund, no questions asked.

ESCORT
Department 501675
5200 Fields-Ertel Road
Cincinnati, Ohio 45249

© 1995 CMI

ONLY PASSPORT 5000 GIVES YOU THE TOTAL PICTURE™

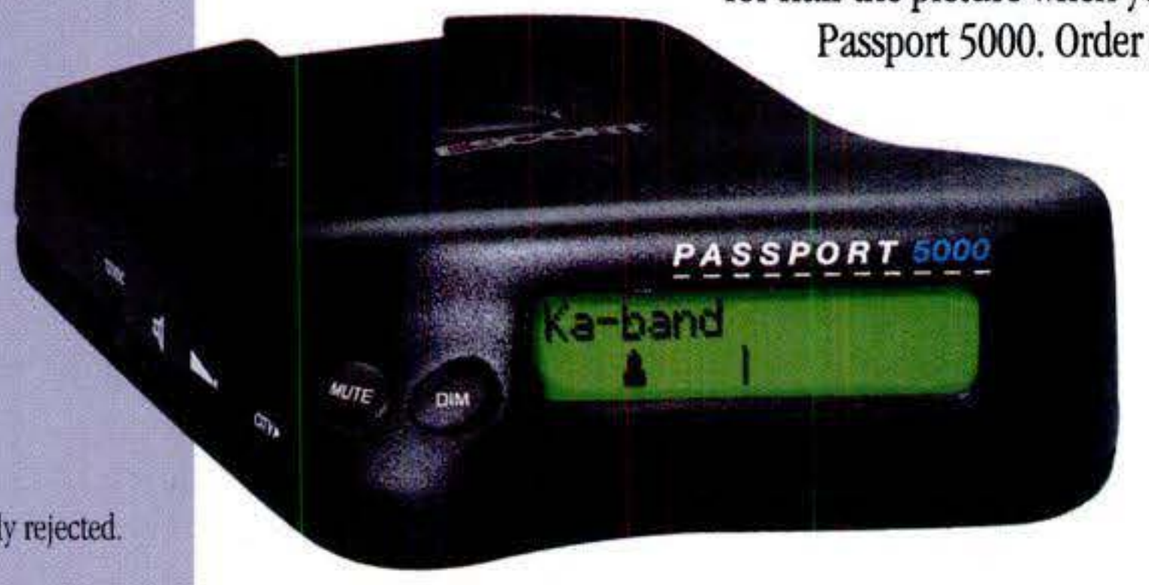
Passport 5000's Total Picture™ technology, available only from Escort, is a new innovation for radar/laser detection. Like a CD player, Passport 5000's LCD screen visually displays information, eliminating the guesswork common with LED-style panels.

Are you approaching a dangerous road hazard? Total Picture™ alerts you to potentially hazardous road conditions in those cities now using the new safety technology.

Getting the same radar alert every day at the same place? Total Picture™ visually displays when a new second source is present – one that could be a true threat.

Two SuperWide Ka radars being broadcast in the same area? Only Total Picture™ will display *both* alerts at the same time so you don't take either for granted.

Total Picture™ technology takes the guesswork out of radar/laser protection. Don't settle for half the picture when you can get the Total Picture™ with Passport 5000. Order yours today.



The "intelligent choice...for those shopping for high performance detection and highway safety combined."
CORVETTE FEVER

With SafetyPilot™ Technology!

SAFETYPILOT™ GIVES YOU THE BIGGER PICTURE...

Passport 5000's unique SafetyPilot™ technology alerts you to the presence of emergency vehicles and road hazards (highway construction, accidents, dangerous intersections, unmarked railroad crossings) in those cities using the new safety technology. Drive with peace-of-mind knowing Passport 5000 is protecting you and your passengers.

Get the Total Picture™ Only with Passport 5000. Only from Escort.

for the total driving picture, call toll-free:

1•800•433•3487

Open 24 hours, 7 days a week for your convenience.

new price!

Passport® 5000 $169.95

Shipping & handling is extra. OH res. add 6% sales tax.

The Innovative Edge.™

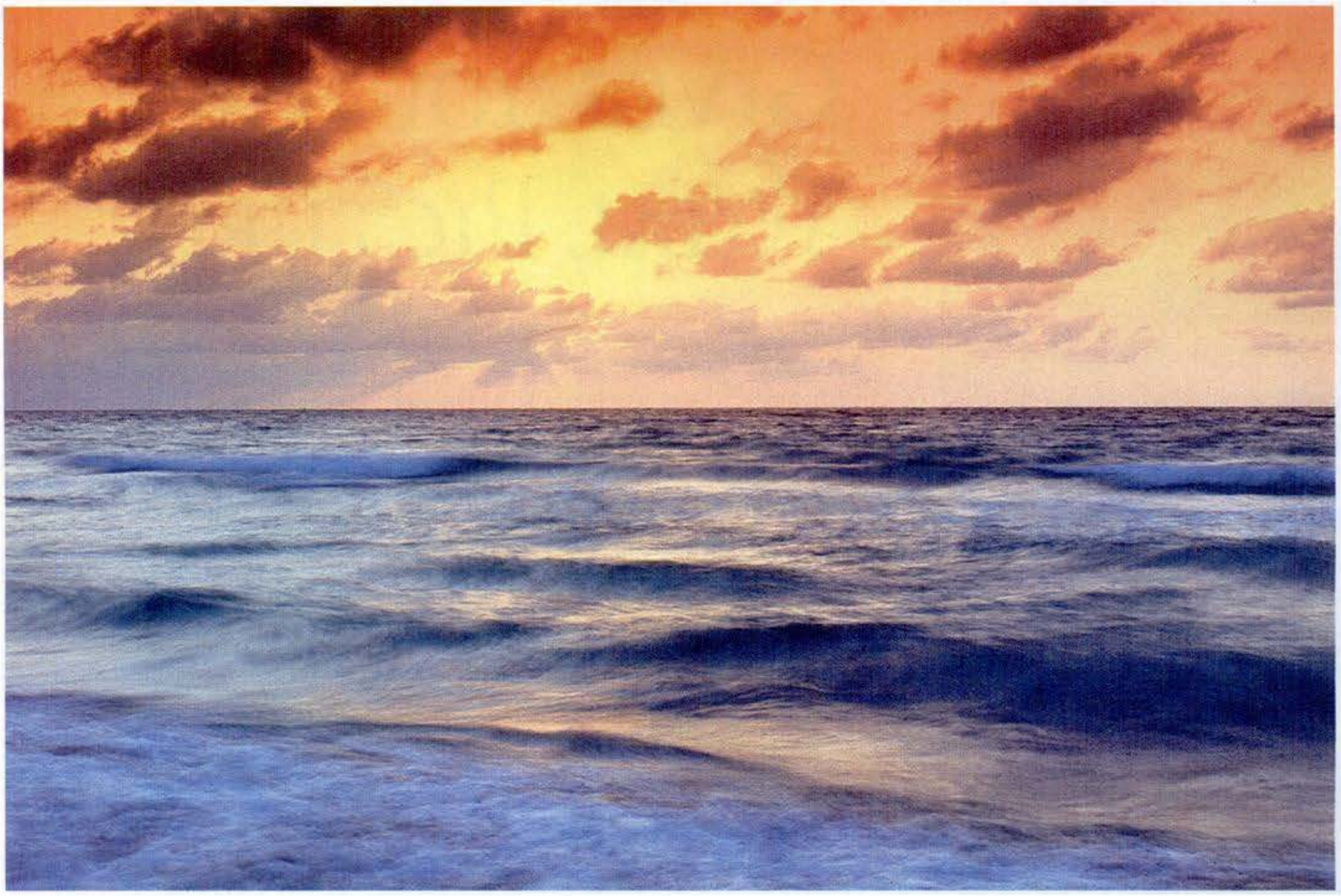
ESCORT

COMPLETE Radar • Laser PROTECTION

SafetyPilot™ Technology

Copyrighted material

CARS AREN'T THE ONLY BODIES WE'RE CONCERNED ABOUT.



That's why Ford Motor Company is proud to be a sponsor of Ocean Planet. *Glorious in scope, the Smithsonian Institution's traveling exhibition dramatically illustrates how all life is affected by the health of the ocean and highlights the urgent need for ocean conservation. Our support of* Ocean Planet *underscores an ongoing commitment to ENVIRONMENTAL concerns. Back in 1903 Henry Ford himself designed suppliers' shipping crates so they could be dismantled and used as running boards and wooden trim, reducing packing waste. Since then our engineers have continued to create INNOVATIVE ways of protecting our environment such as recycling and reducing harmful emissions, as well as developing cars that run on electricity and NATURAL gas. We're honored to be a part of* Ocean Planet, *and we urge everyone to visit the exhibition and learn what we can do to assure our world's survival. A topic that's a concern to us all.*

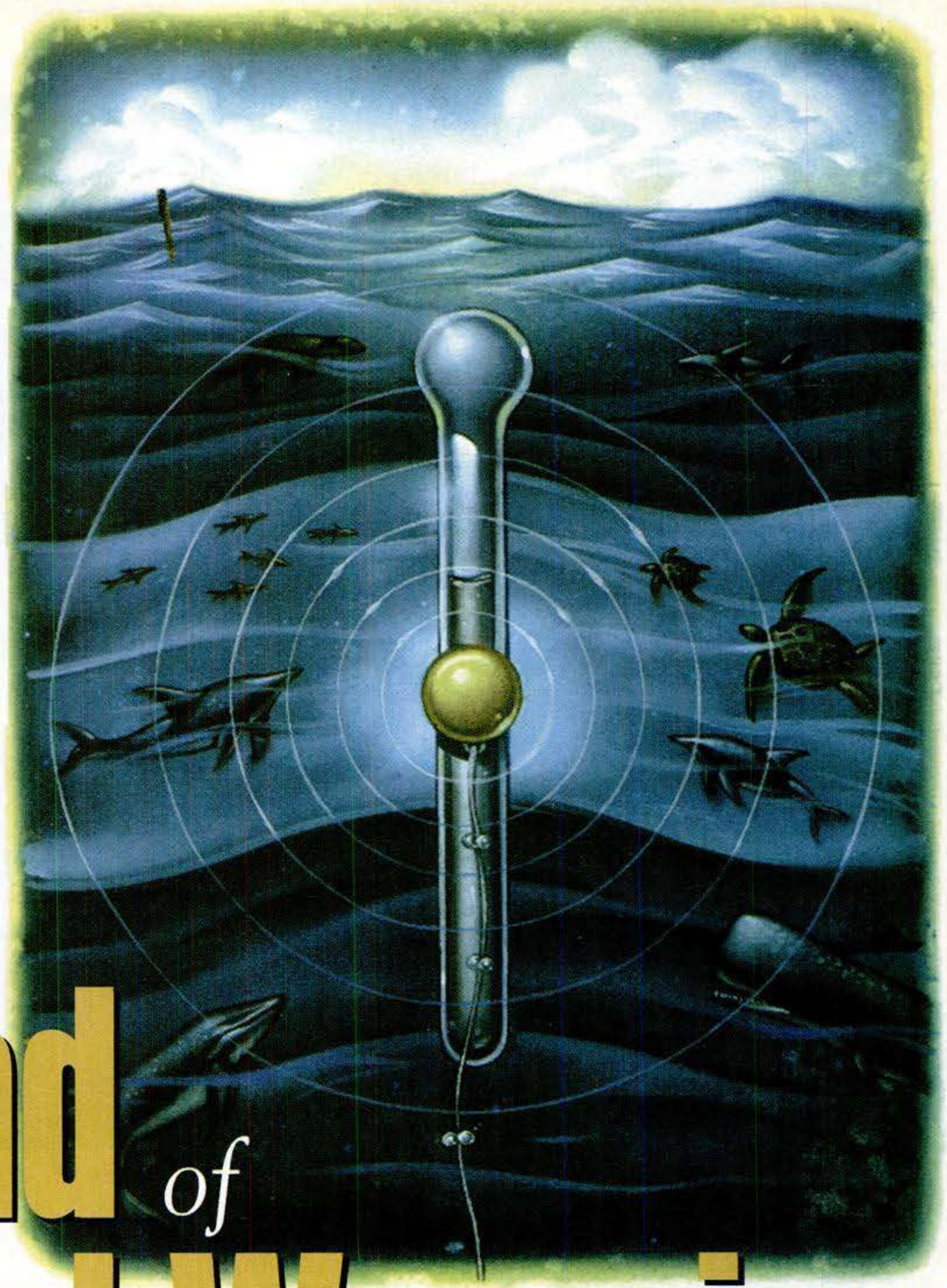
Ford

QUALITY IS JOB 1™

OCEAN PLANET
SMITHSONIAN

Copyrighted material

Cold War spy technology could become the world's largest ocean thermometer to measure global warming. But will the residents object?



The Sound of Global Warming

BY STUART F. BROWN

A program that uses sound waves to measure ocean temperatures could improve global climate models but may be scrapped if whales and sea lions don't like it.

The Scripps Institution of Oceanography in La Jolla, Calif., hopes to inaugurate a $35 million program to measure temperatures beneath the surface of the Pacific Ocean. Knowing whether ocean temperatures are rising or falling over time would greatly increase the accuracy of computer models designed to predict climate change.

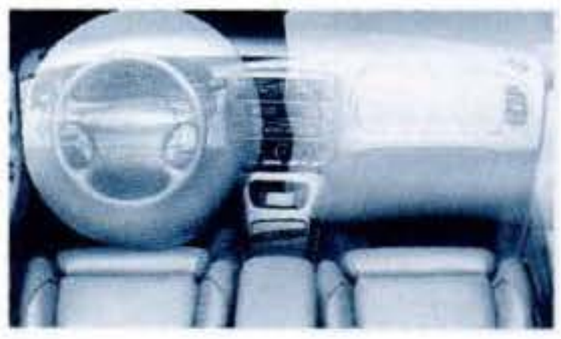
But the Scripps program—called the acoustic thermometry of ocean climate (ATOC)—uses low-frequency sound waves to determine ocean temperature. This has some marine mammal experts and environmentalists concerned because sea creatures such as blue whales, elephant seals, and sea lions either have hearing ranges that can detect ATOC sound waves or occasionally dive to depths where the sound-generating devices would operate. "This sound will travel though more than a quarter of the whole Pacific," says whale biolo-

CARY HENRIE

Copyrighted material

Over 75% of the new Explorer can be recycled, thanks to innovative materials and new manufacturing technologies.

*The top-selling sport utility with standard dual air bags.**



Introducing The New Ford Explorer. Creating A Better Environment. Inside And Out.

The new Explorer has CFC-free air conditioning, which doesn't deplete the world's ozone layer.

Explorer's new instrument panel has large, easy-to-use radio controls.

Free 24-Hour Roadside Assistance for 3 years/36,000 miles. See dealer for details.

*Always wear your safety belt.

Copyrighted material

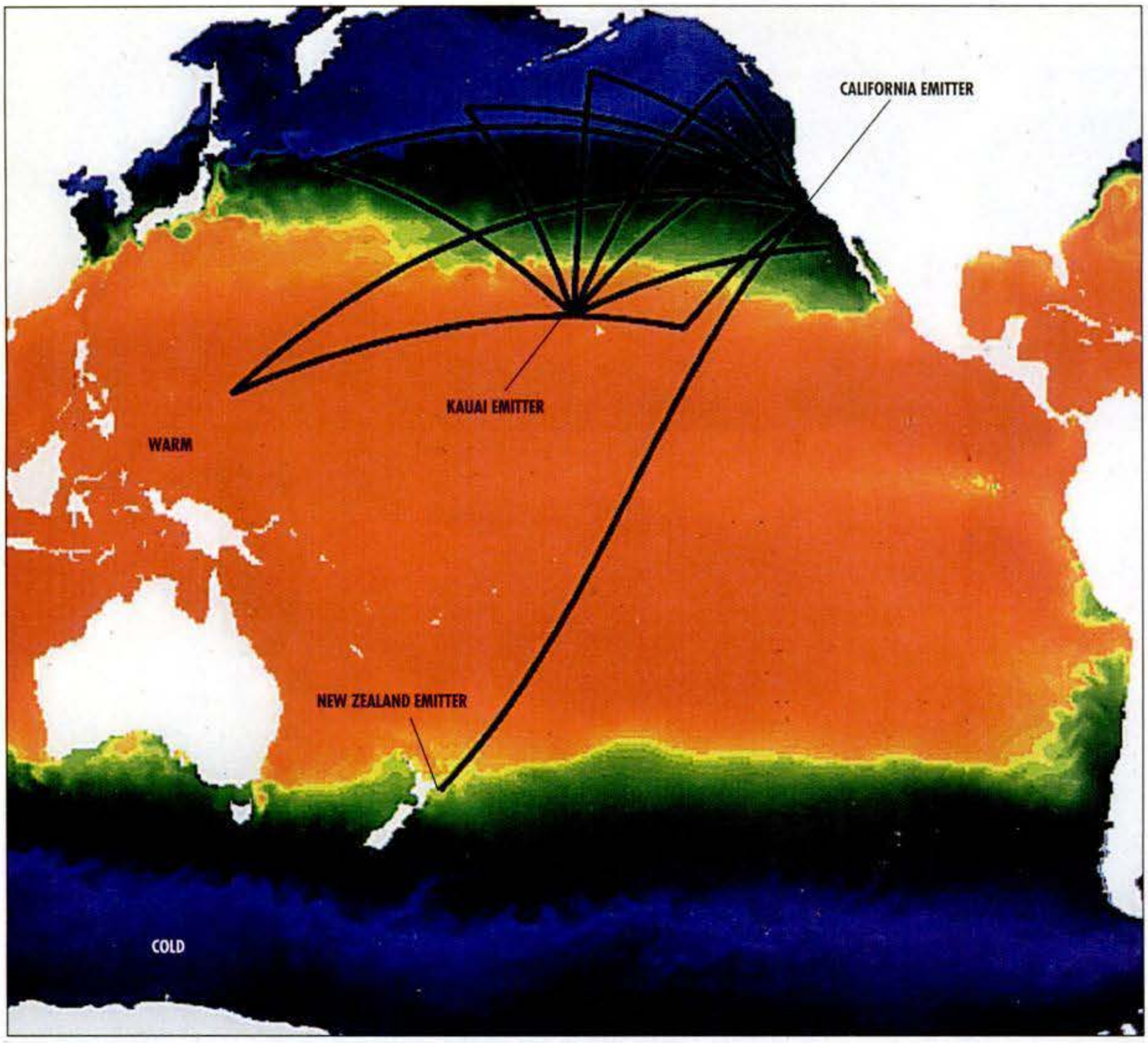
Explorer has more room than any top-selling compact sport utility and offers exclusive reclining rear seats for even more comfort.

OCEAN PLANET
SMITHSONIAN

Unique new floor console has rear controls for radio, heating and air conditioning.

Ford

Copyrighted material



Underwater microphones in the Pacific Ocean will measure average deep-water temperatures by clocking the travel time of sound from submerged emitters off California and Hawaii. Colors indicate local temperatures.

gist Linda Weilgart of Dalhousie University in Nova Scotia, who triggered the controversy in a flurry of Internet exchanges last year. "You've got to be sure you're not affecting the long-term welfare of marine mammals, such as fertility rates, growth, and mortality" before going ahead with the program, she says.

The controversy over the Scripps ATOC program is especially ironic, since it pits animal-protection advocates such as the Sierra Club and the Natural Resources Defense Council against scientists who believe the program could help us learn more about one of the biggest mysteries of the environment—global warming. The ocean plays a bigger part in global climate than most people realize. "Most of the heat that powers the climate is stored in the seas," says oceanographer Walter Munk, the project's principal investigator. "You won't get the atmospheric climate prediction straight unless you get the ocean climate prediction straight."

Measurements of ocean-surface temperatures can be made by satellites, but their radar or infrared instruments are only capable of sensing the top few millimeters of water. Deep waters, which contain most of the ocean's heat, can also be sampled by oceanographic research ships dispensing sensing instruments. This process is expensive, however, for the amount of data gathered. ATOC's proponents argue that acoustic thermography's ability to sense the average temperature of an immense volume of water makes it the most practical method.

Using sound waves to measure water temperature has its origins in a 1944 experiment by Maurice Ewing of Columbia University, who discovered a natural "channel" in the sea that could carry sound waves across vast distances. This sound channel, at a depth of about 2,800 feet, is a seam of medium-temperature water that's isolated by a layer of warmer surface water above, and a layer of cooler, deep water below. The thermal and pressure barriers on either side of the middle-depth layer act as a wave guide, keeping certain sound frequencies bouncing between its two "walls" [see diagram]. Ewing's original experiment proved this when an underwater explosion was detected 900 miles away.

The U.S. Navy was quick to realize the implications of Ewing's work. It developed sound fixing and ranging (SOFAR), a method that uses hydrophones, or submerged microphones, to pick up noises underwater. For example, the noise of vibrating machinery aboard Soviet submarines was detected from one thousand miles away by SOFAR monitoring of the oceanic sound channel. "SOFAR was a mainstay of U.S. security during the Cold War," says Munk. "This method was our main source of information about one of Russia's most threatening activities."

Curiously, a Soviet scientist had independently discovered the sound channel in a 1946 experiment, but for some reason the Soviet navy didn't capitalize on the findings. Soviet strategy changed abruptly in the 1970s, when spies revealed the success of SOFAR. Much quieter Soviet submarines were soon in service.

By the late 1970s, Munk was pioneering the techniques that would lead to acoustic thermography. He performed acoustic tomography experiments, using multiple sound emitters and receivers to produce three-dimensional temperature maps of areas of the sea. The method exploited a natural phenomenon: Sound travels faster in warm water than it does in cold water. Therefore, the average temperature of the water can be determined by clocking the travel time of low-frequency sound from its source to a receiver. For example, water warmer by a mere five one-thousandths of a degree decreases sound travel time across a 6,000-mile path by 150 milliseconds.

In 1991, Munk led a test program which showed that an underwater sound source exploiting the sound channel could be broadcast over great distances. A signal transmitted underwater from Heard Island in the southern Indian Ocean near Antarctica was detected by sensors 11,000 miles away. This experiment

Copyrighted material

opened the door for ATOC, which uses a pair of sound emitters and an array of sensors to measure temperatures across vast areas of the Pacific.

ATOC sound emitters produce low grumbles of 75 hertz that are transmitted in coded 27-second sequences and are repeated 43 times for a total of about 20 minutes. The coding identifies the signal, which weakens and becomes buried in the ocean's random noise before it arrives at a receiver. Repetition provides replacements for individual signals that may be canceled out by background noise en route. Each chunk is tagged with its exact departure time. Computers then correlate clearly received chunks of different sequences into a precise measurement of sound travel time.

"Actually detecting climate change in the oceans will take at least a decade, and 20 years would be even better," says ATOC program manager Andrew Forbes. "If you only measure for five years, you may find yourself tracking a trend that is just riding on the back of an El Niño," Forbes says. "So you have to get beyond those known periodicities in the ocean and atmosphere and measure at least a couple of normal cycles."

The mission plan calls for one sound source to be anchored in the waters at Pioneer Seamount off central California, and another to be placed eight miles off the north shore of Kauai, Hawaii. An assortment of acoustic receiving devices located 3,000 to 6,000 miles distant will collect sound waves and convert them into average temperature measurements along 18 paths through the Pacific. The Navy has agreed to allow researchers access to part of its once-secret network of submarine-detecting hydrophones.

Once the ATOC network is established in the Pacific, the equipment will gather temperature measurements for 24 months. Forbes hopes the early insights gained into the thermal characteristics of the Pacific will lead to the development of a long-term acoustic thermometry network monitoring large ocean areas, particularly in the Atlantic, where major flows of cold, polar bottom water enter the global ocean.

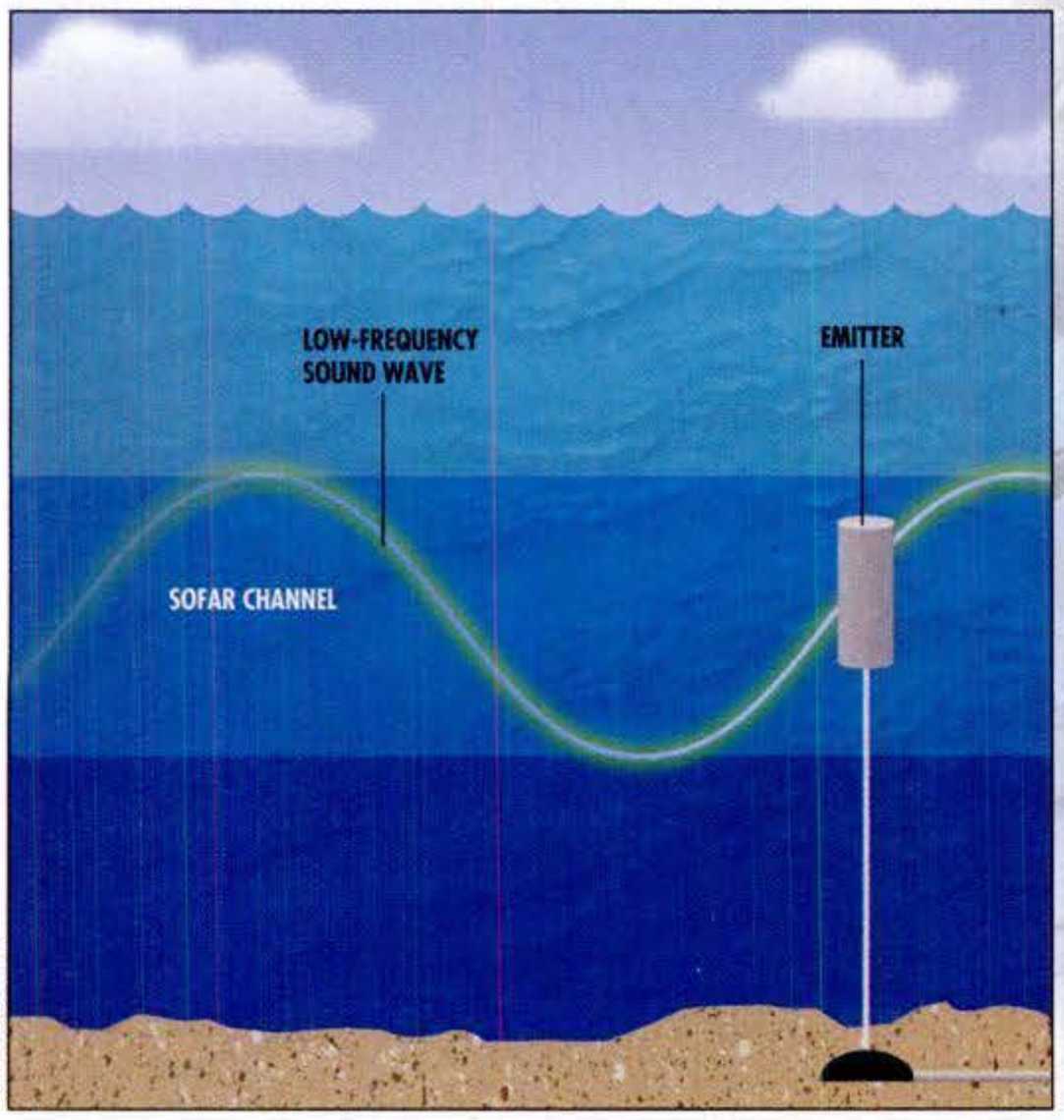
But the entire program hinges on the outcome of a six-month test aimed at determining if ATOC sound sources harm marine mammals. If federal and state permits are issued—perhaps as early as this summer—researchers will gradually bring the omnidirectional sound emitters up to full power for 20-minute transmissions for four-day periods, alternating with week-long periods of silence. Time-depth recorders will be attached to marine mammals in the neighborhood, and their swimming speeds and patterns, along with heart and respiratory rates, will be monitored.

Still, marine biologist Christopher Clark, head of the ATOC marine mammal study, is embittered by the controversy. He feels that opposition to the program is grounded in emotion rather than scientific fact. "This is environmental activism gone completely astray," Clark says. "They should be focusing on the real acoustic pollution in the sea, which is the barrage of noise from supertankers and other shipping traffic."

If ATOC clears regulatory hurdles, Walter Munk and his acoustic oceanographers will transform a Cold War submarine snooping technique into the biggest thermometer in the sea. Scripps scientists plan to share data with researchers at NASA's Jet Propulsion Laboratory, who are now receiving ocean surface-height measurements from the orbiting *Topex-Poseidon* spacecraft. "The satellite altimetry gives you the temperature of the upper oceans, because when they are warmer the water level is higher," Walter Munk explains. "With ATOC, we get the temperature structure of the interior ocean. We will use these two views to help produce a good climate-prediction model, which we think does not now exist." PS

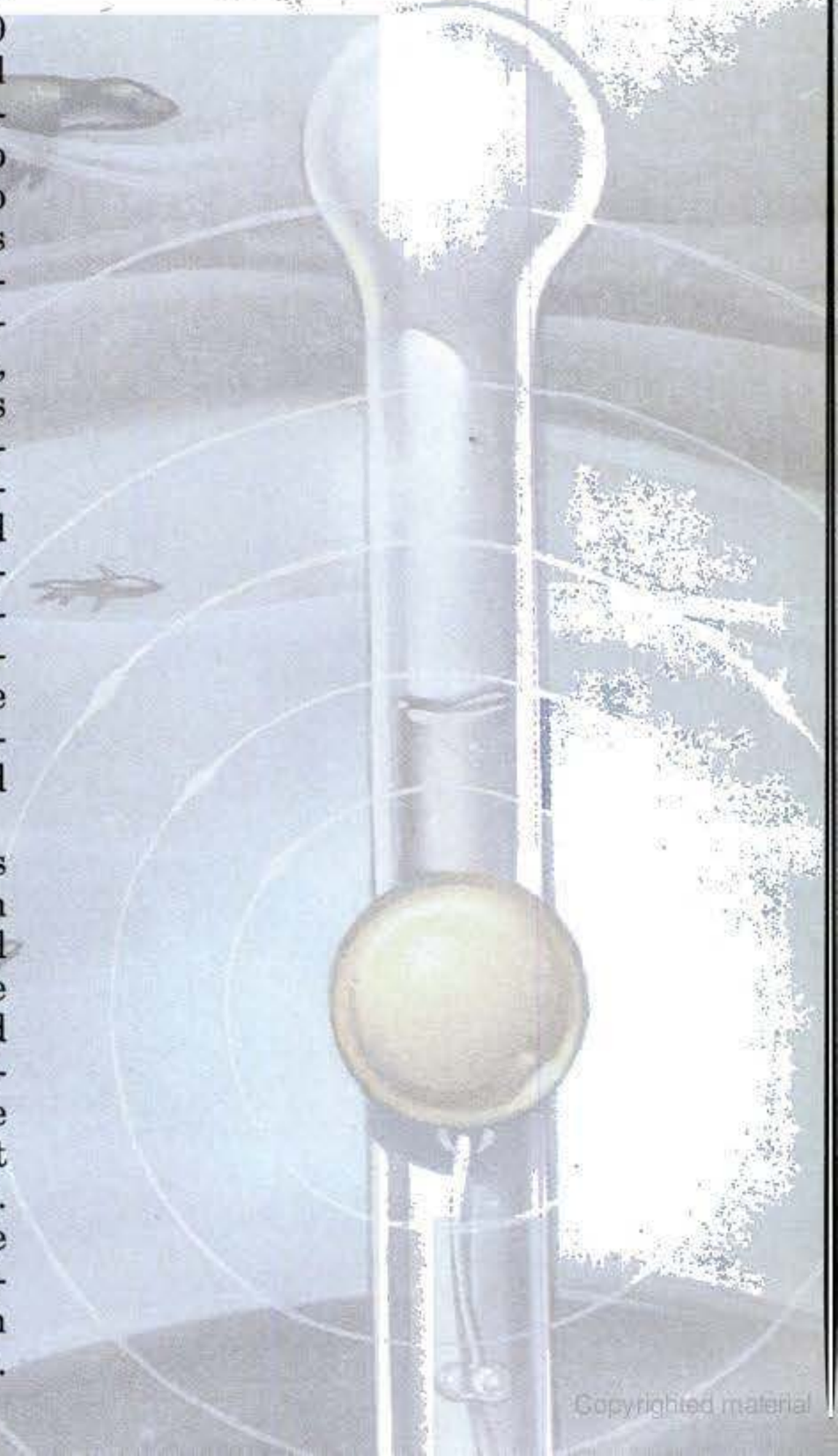
Sound intensity from the ATOC microphones, which at 195 decibels roughly equals the noise of a large container ship at close range, diminishes rapidly as it radiates. At 2,700 feet from the source, the sound level decreases to 136 decibels, the equivalent of breaking waves, according to program officials. "We don't expect to see distress in these animals," says Daniel Costa, a marine biologist at University of California, Santa Cruz, who is heading the $2.9 million study on the effects of ATOC sound waves on sea mammals. "What we expect to see, if anything, is that the animals would express annoyance and avoid the site."

Program managers at Scripps have given the marine mammal group control of the sound emitters and the authority to modify or halt the entire program if they detect harm to sea life. Ocean temperature measurements will begin only if the system is found to be safe.



ROB SCHUSTER

An ATOC emitter generates low-frequency sound that becomes trapped in the ocean's middle layer and travels vast distances.



Copyrighted material

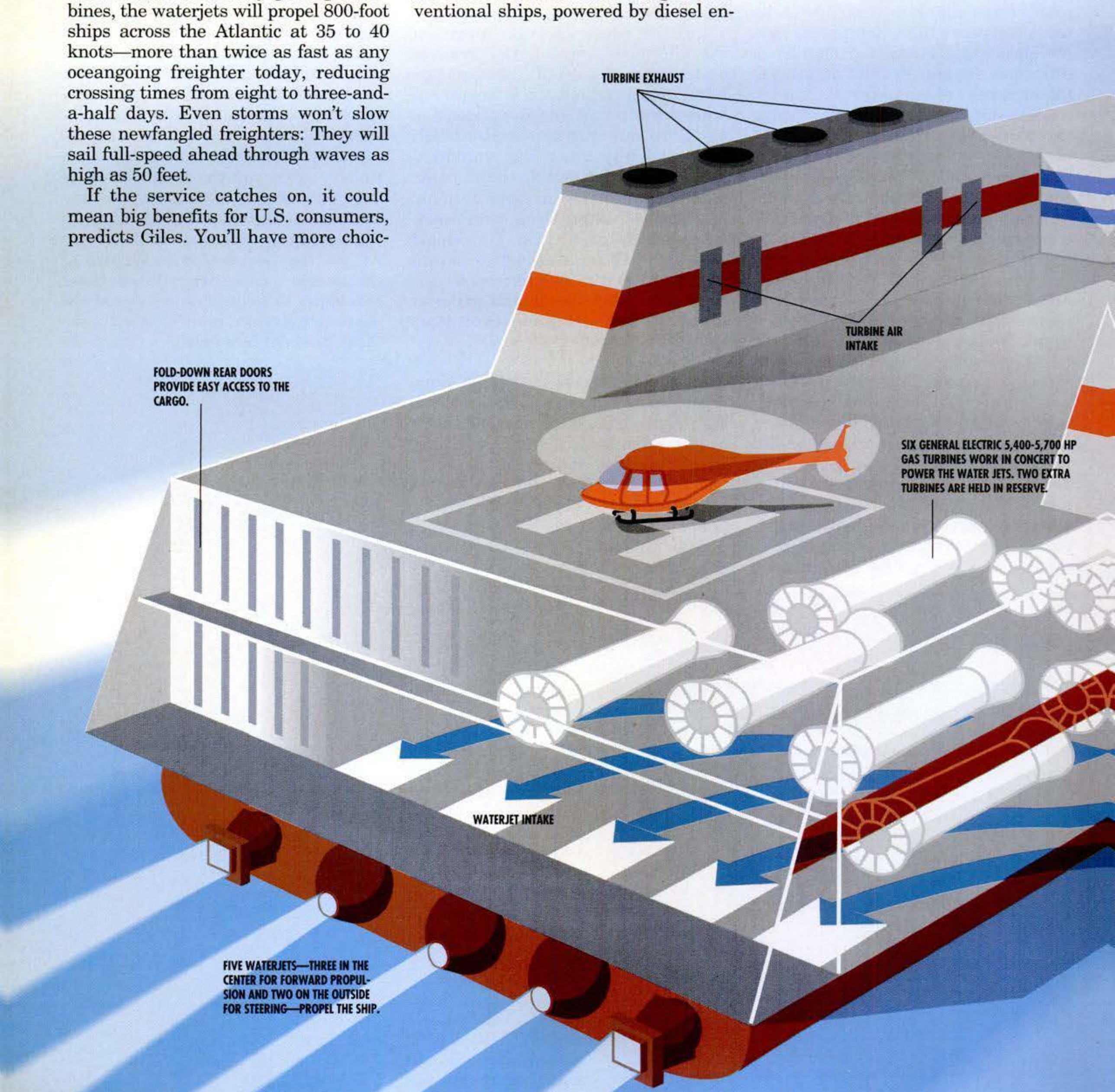
Welcome to the jet age of cargo shipping," brags aeronautical engineer David Giles. Giles is not talking about jet aircraft, however, but cargo ships—waterjet-propelled cargo ships. The company he helped found, Fastship Atlantic Inc. of Alexandria, Va., intends to build a small fleet of such vessels by the end of the decade. Powered by giant gas turbines, the waterjets will propel 800-foot ships across the Atlantic at 35 to 40 knots—more than twice as fast as any oceangoing freighter today, reducing crossing times from eight to three-and-a-half days. Even storms won't slow these newfangled freighters: They will sail full-speed ahead through waves as high as 50 feet.

If the service catches on, it could mean big benefits for U.S. consumers, predicts Giles. You'll have more choices at the car dealer, fresher produce at your grocery store, and better prices for custom-order electronics items. Swedish carmaker Volvo—a Fastship supporter—expects Fastship to slash shipping times for its cars from 38 days to 14, for example. That should make it much more practical to order a car with the options you want, rather than just choosing from what dealers have in stock.

The secret behind the Fastship concept is the combination of waterjets and ultra-powerful gas turbines, with an unconventional hull design. Conventional ships, powered by diesel engines and propellers, cruise efficiently at speeds of approximately 18 to 24 knots. At higher speeds, a vacuum forms around propellers due to a well-known effect called cavitation, which retards forward movement. Worse, the sterns of conventionally hulled ships sink as they exceed cruising speeds, creating more drag and further reducing efficiency.

Waterjets, which don't rely on mov-

DIXON ROHR

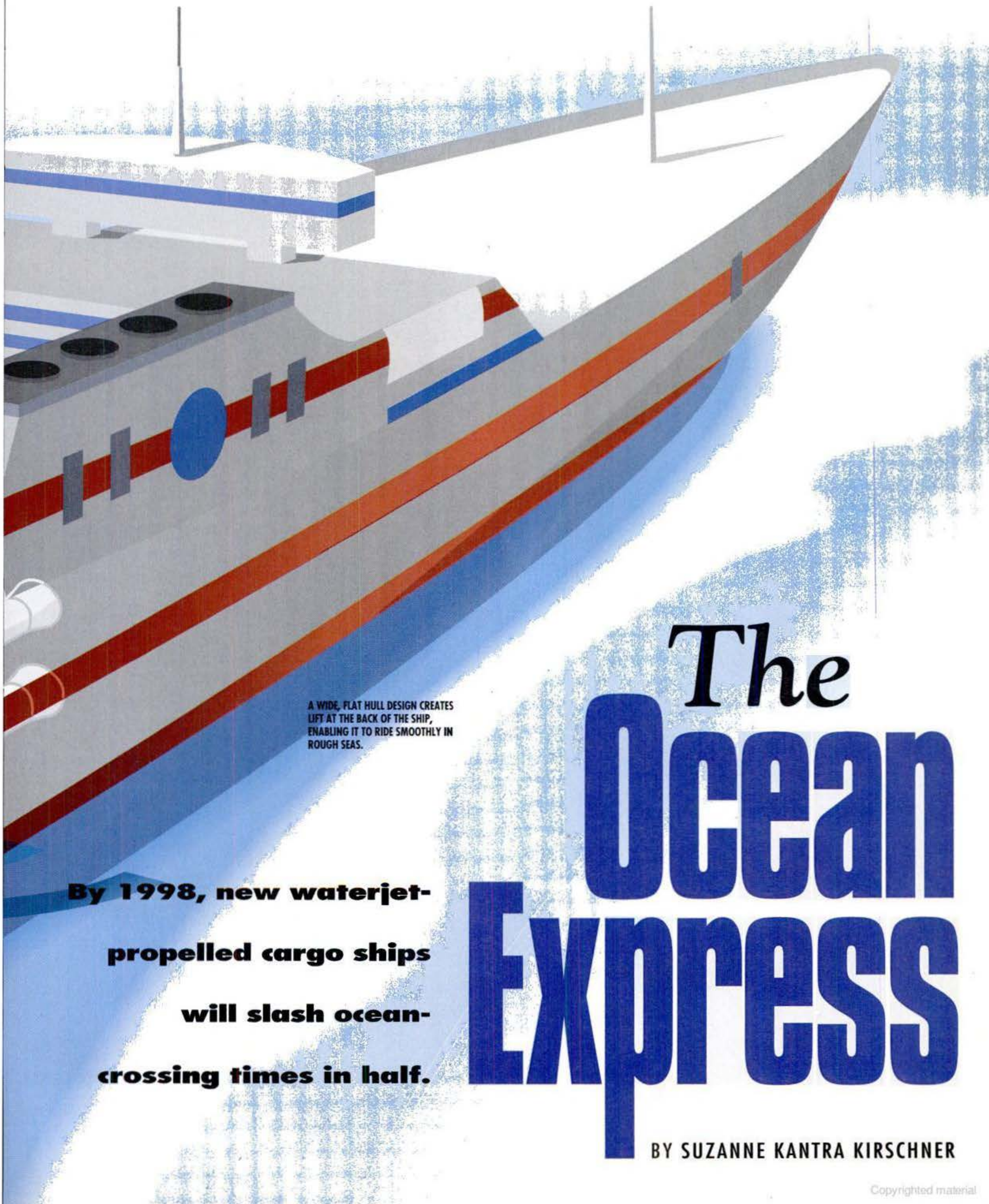

TURBINE EXHAUST
TURBINE AIR INTAKE
FOLD-DOWN REAR DOORS PROVIDE EASY ACCESS TO THE CARGO.
SIX GENERAL ELECTRIC 5,400-5,700 HP GAS TURBINES WORK IN CONCERT TO POWER THE WATER JETS. TWO EXTRA TURBINES ARE HELD IN RESERVE.
WATERJET INTAKE
FIVE WATERJETS—THREE IN THE CENTER FOR FORWARD PROPULSION AND TWO ON THE OUTSIDE FOR STEERING—PROPEL THE SHIP.

Copyrighted material

ing parts, reach their maximum efficiency at much higher speeds. But until now, they've been limited to high-speed ferries and other relatively short transport vessels. The problem: No engines existed with the combination of size and efficiency to satisfy the enormous power requirements of ships larger than a few hundred feet. Indeed, the lack of a fuel-efficient power source has sunk many high-speed freighter proposals in the past.

But in the early 1990s General Electric crafted the LM 6000 gas tur-

[Continued on page 84]



A WIDE, FLAT HULL DESIGN CREATES LIFT AT THE BACK OF THE SHIP, ENABLING IT TO RIDE SMOOTHLY IN ROUGH SEAS.

The Ocean Express

By 1998, new waterjet-propelled cargo ships will slash ocean-crossing times in half.

BY SUZANNE KANTRA KIRSCHNER

Copyrighted material

THE FORECAST FOR

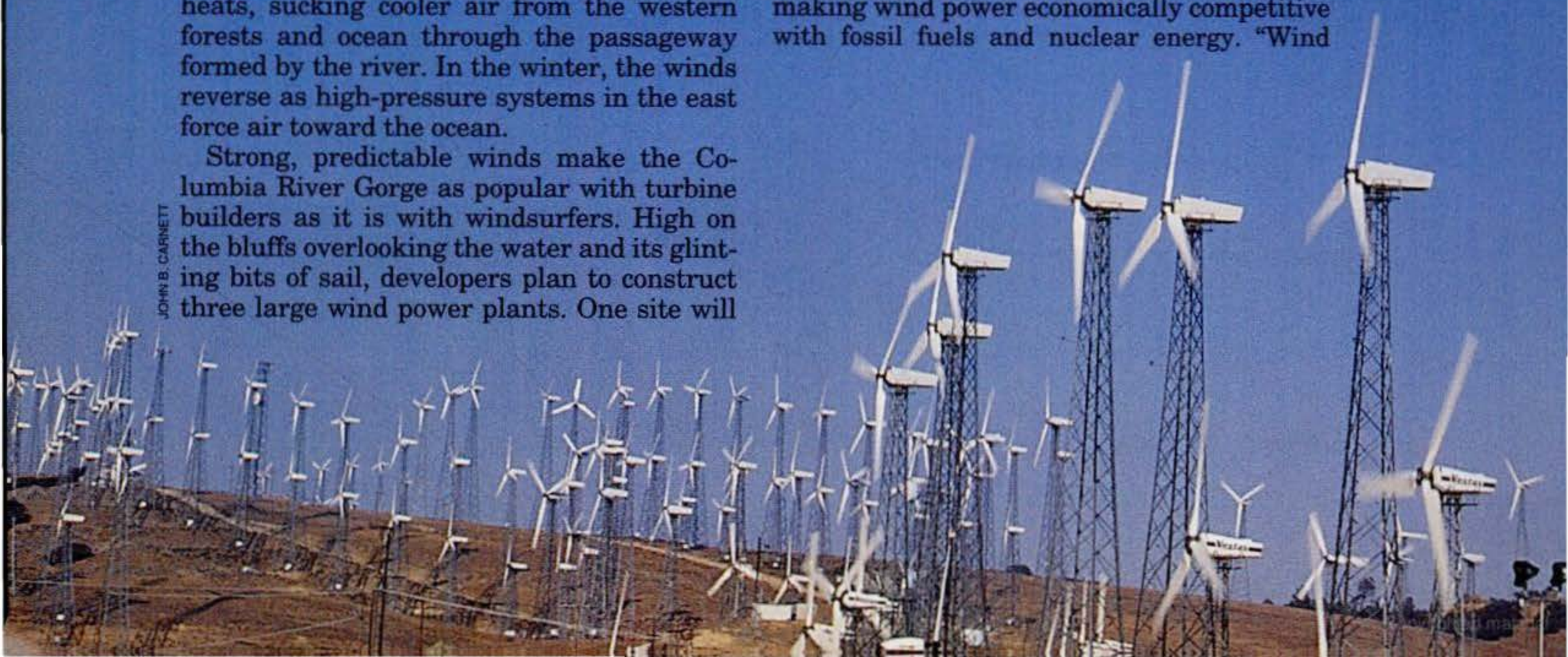
WIND POWER

BY DAWN STOVER

In its mad rush toward the ocean, the Columbia River long ago carved a deep gorge through the Cascade mountain range of the Pacific Northwest. The gorge is famous for its winds, which in the summer blow hundreds of brightly colored sailboards back and forth across the river. During the warm season, desert air in eastern Oregon and Washington rises as it heats, sucking cooler air from the western forests and ocean through the passageway formed by the river. In the winter, the winds reverse as high-pressure systems in the east force air toward the ocean.

Strong, predictable winds make the Columbia River Gorge as popular with turbine builders as it is with windsurfers. High on the bluffs overlooking the water and its glinting bits of sail, developers plan to construct three large wind power plants. One site will be dotted with big, heavy machines modeled after trusty farm equipment. Another will have small, lightweight turbines designed with an emphasis on aerodynamics. And the third will have variable-speed wind machines that rely on sophisticated electronics.

Not only are these three designs much more reliable than the turbines of a decade ago, they are also so efficient that they are making wind power economically competitive with fossil fuels and nuclear energy. "Wind



JOHN B. CARNETT

Affordable electricity from the wind? Advanced turbine technology is making it a breeze.

Zond's prototype Z-40 turbine (foreground) forms part of a "wind wall" at Tehachapi Pass in California.

power today is a lot cheaper than most people realize," says Kenneth C. Karas, president of Zond Systems, a wind-turbine maker in Tehachapi, Calif.

Wind turbines are not a recent invention. Persians devised crude wind machines to grind grain as early as the seventh century. By the seventeenth century, Don Quixote was tilting at them on the plains of La Mancha. In the United States, farmers and ranchers used more than 500,000 windmills to pump water before the advent of rural electrification. By the 1970s, people living "off the grid" had begun using wind turbines to produce power for homes. But only since 1981 have wind machines been used on a large scale to generate electricity for utilities.

The potential of wind power is enormous. Just one percent of Earth's winds could theoretically meet the entire world's energy needs. Within the United States, wind could generate all of the electricity used today, even when land restrictions are taken into account. North Dakota alone could supply more than a third of the country's electricity needs.

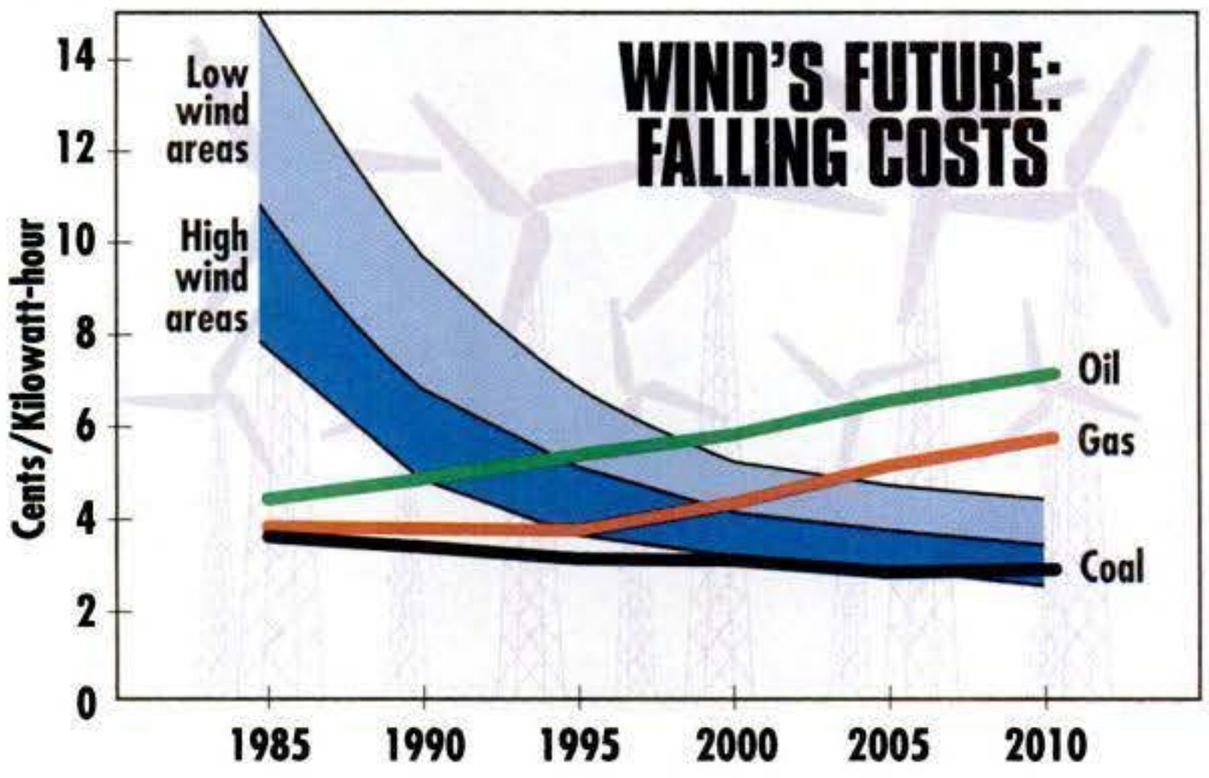
Not only is wind power plentiful, but it is popular with the public because of its environmental benefits. Wind turbines are recyclable. They do not contribute to air pollution, acid rain, global warming, or ozone destruction. They do not create hazardous waste or unsightly mines. They do not siphon water from rivers. They do not chop fish into little pieces. They do, however, sometimes kill birds [see "Birds and Blades"].

Today more than 17,000 turbines spin power into the U.S. grid, mostly in California. Wind machines currently produce less than 1 percent of the nation's electricity, but their contribution is growing quickly. The U.S. Department of Energy forecasts a sixfold increase in the nation's wind-energy use during the next 15 years. The American Wind Energy Association, the industry's trade group, predicts that wind will provide at least 10 percent of the nation's energy needs by the year 2050.

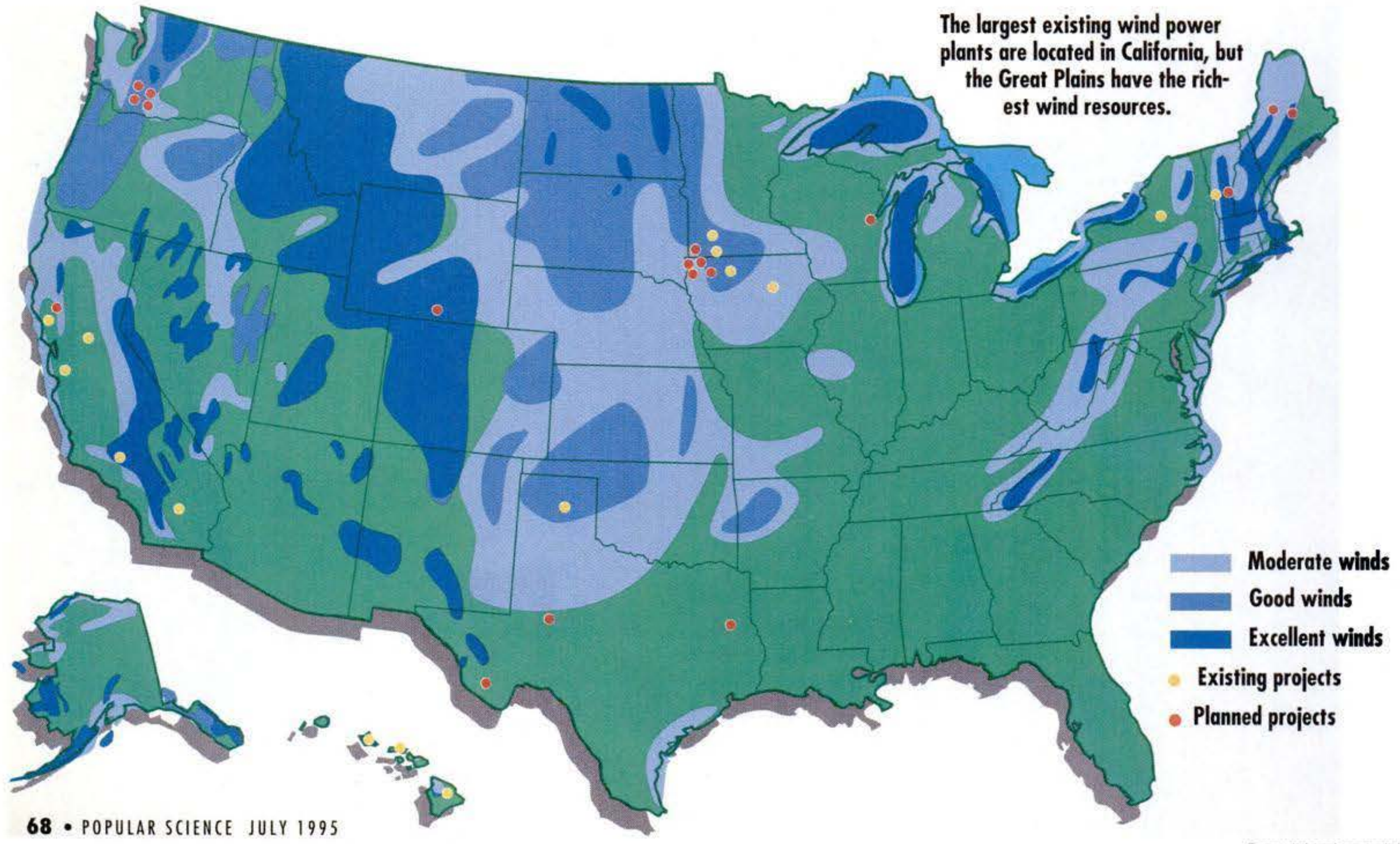
The Columbia River Gorge is just one of many windy areas targeted for development. Within the next year or so, large wind farms are also planned for Wyoming, Iowa, Minnesota, Texas, Vermont, and Maine [see map]. These farms are expected to add about 400 megawatts of generating capacity to an existing 1,700 megawatts in the United States. Existing wind turbines already supply enough power for close to a half-million homes.

Wind energy is growing internationally too. Europe already has almost 2,000 megawatts of generating capacity and aims to double that by the year 2000. One European country, Denmark, has set a goal of producing 10 percent of its electricity from the wind by the turn of the century. Major wind projects are also underway in Canada, India, Argentina, Ukraine, China, Costa Rica, and New Zealand.

Advanced turbine technology is the biggest reason for wind power's declining cost. "No longer will wind energy be seen as the domain of a disheveled miller with corn flour in his hair, furling the cloth sails on his wooden windmill," writes Paul Gipe in his new book, *Wind Energy Comes of Age*. "This archaic image has given way to that of trained professionals tending their sleek aeroelectric generators by computer." Larger turbines, new blade designs, advanced



MAP AND CHART: GERALD RUSSELL


The largest existing wind power plants are located in California, but the Great Plains have the richest wind resources.
Moderate winds
Good winds
Excellent winds
Existing projects
Planned projects

Copyrighted material

materials, smarter electronics, flexible hub structures, and aerodynamic controls are all contributing to improvements in efficiency.

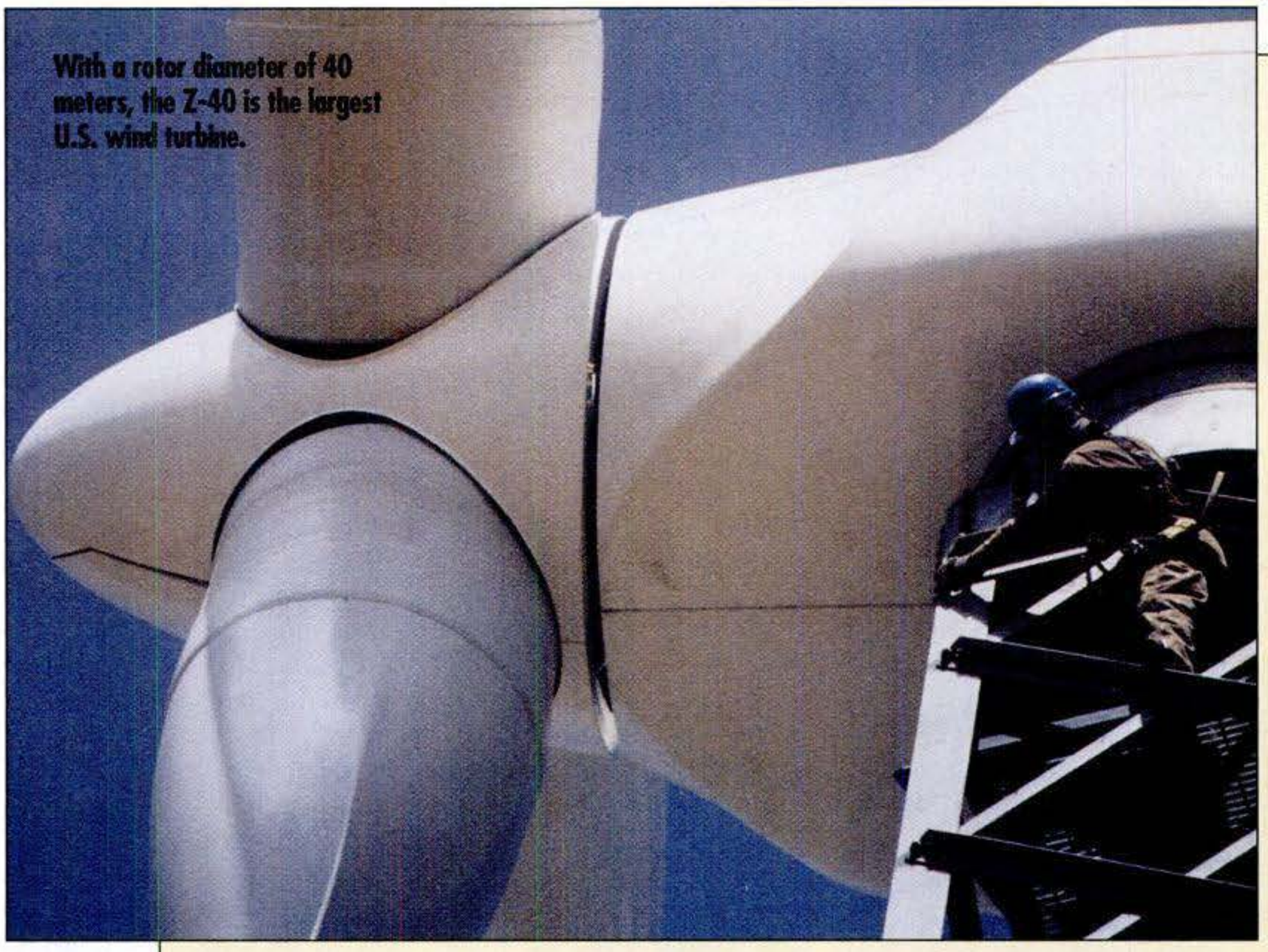
"The wind industry today is in many ways analogous to the airplane industry of the 1930s," says Steven P. Steinhour, lands and permits director of Kenetech Windpower, the world's largest wind company. Indeed, some of the most interesting new technologies rely on ideas borrowed from aircraft designers. For example, many of the prototype turbines sprouting at wind farms have computer-designed airfoils. A few even have aircraft-type control surfaces like ailerons.

Wind blowing past a turbine doesn't "push" its blades around like the arms of a pinwheel. Rather, the blades work somewhat like the wings of an airplane. Air passing over a blade's upper surface travels farther than air crossing the underside, resulting in a pressure difference that creates lift. As lift drives the blades forward, they turn a drive shaft connected to a generator.

Not long ago, engineers made turbine blades from helicopter rotors and sailplane wings. But as it turns out, these components are not ideal for wind machines. Aircraft wings are designed to maximize lift and prevent stalls, even if that means increased drag and the resulting reduced efficiency. But turbine blades don't carry precious human cargo, so stalling isn't so worrisome. In fact, some turbine designers intentionally create blades that will stall, or slow, in high winds to prevent turbine damage. Stalling occurs when the blade's angle of attack becomes so steep that the airflow around the blade is too turbulent to produce lift.

The National Renewable Energy Laboratory has helped a number of U.S. wind companies develop airfoils that are designed specifically for wind turbines. When a conventional turbine was retrofitted with these airfoils, its energy capture increased by about 30 percent. In a sign of the changing times, the lab recently constructed a wind technology center at Rocky Flats, a former nuclear-weapons plant outside Denver.

The shape of the new airfoils also makes them less susceptible than aircraft wings to "roughening" from collisions with insects. This isn't a problem



With a rotor diameter of 40 meters, the Z-40 is the largest U.S. wind turbine.

TRUSTY AS A TRACTOR

In the 1980s, most turbines installed in the United States were made overseas—primarily in Denmark, Germany, and the Netherlands. The Danes and other Europeans build their machines like tractors: heavy and rugged. It's no coincidence that many European turbine makers also sell farm machinery. Windmills were once standard equipment on farms.

Following in that tradition, the Z-40 turbine from Zond Systems of Tehachapi, Calif., is modeled after a widely used Danish machine named Vestas, with a few refinements. The largest turbine in the United States, the Zond has a three-blade rotor that's 40 meters in diameter, or about 130 feet. The blades, rotor hub, and minivan-size nacelle (the housing for the drivetrain, gearbox, and generator) together weigh about 55,000 pounds.

The two Z-40 prototypes at Tehachapi, like most turbines sold today, are designed to turn at a constant speed so that they will consistently crank out electric current at the 60Hz frequency required by the U.S. power grid. The generator creates drag to keep the blades rotating at the correct speed. But if the generator burns out, or the power grid shuts down, the turbine can overspeed—spinning at such high rates that the blades can snap. To prevent overspeeding, turbines are designed to stop rotating in dangerously high winds or power outages. They also disconnect from the generator, or stop altogether, when winds are too feeble to turn the blades at the correct speed.

One Z-40 prototype shuts down at wind speeds above 65 mph by feathering its fiberglass blades—turning them parallel to the wind. Like an airplane propeller, each blade pivots at its root on a giant bearing.

Because the Z-40's blades are so long, the pitch-control system on the first prototype cannot respond instantaneously to gusts. But the second prototype overcomes this limitation by using ailerons. The seven-meter-long ailerons are much shorter than the entire blades, so they can respond faster when wind speed becomes dangerous.

The Z-40 will be the first commercially available machine with ailerons, but other companies are working on prototypes using the concept [see "Flying a Turbine"]. An aileron adds moving parts, but repairs can be done without removing the entire blade. However, the device may not be suited for cold climates, where icing could be a problem; heaters and Teflon surfaces could help prevent ice buildup.

With or without ailerons, a Z-40 costs about $500,000—including turbine, tower, and the construction of roads and power systems. At sites where average wind speed is 15 to 16 mph, the Z-40 will generate electricity for five to six cents per kilowatt-hour, claims Zond president Kenneth C. Karas.

Zond expects to erect more than 100 Z-40s worldwide over the next year. A dozen have already been shipped to the Texas panhandle.

Another machine being developed by Zond could bring the kilowatt-hour cost down by a penny. The Z-46 will be even bigger than the current version, 46 meters in diameter. Zond expects to have a prototype ready by year's end.—*D.S.*

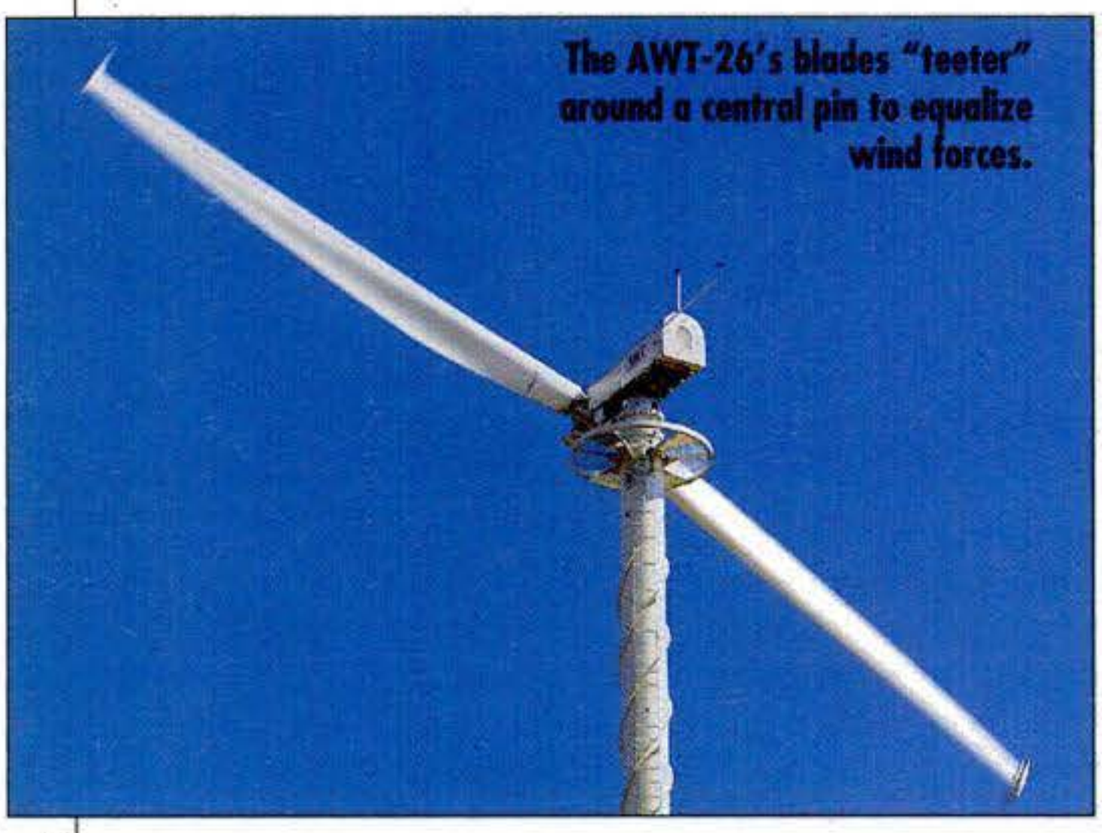
Copyrighted material

OUT OF AIRCRAFT

With its design roots in the helicopter and aircraft industries, the 275-kilowatt AWT-26 machine is only 26.2 meters (86 feet) in diameter and less than a third the weight of the European-style Z-40.

The first thing you notice about the AWT-26, designed by Advanced Wind Turbines of Seattle, is that it has only two blades. In theory, a wind turbine needs only one blade; one Italian turbine has this design. But most wind turbines today have three. The third blade adds stability, which can make the turbine easier to maintain, but it also adds to the weight and price.

Previous two-blade machine designs have racked up high maintenance costs for fatigued components. One reason is wind shear: Air doesn't always move at the same speed, or in the same direction, at different heights above the ground. Therefore, the wind forces acting on the blades of a two-blade turbine aren't always equal.



The AWT-26's blades "teeter" around a central pin to equalize wind forces.

JOHN B. CARNETT

The wind-shear problem for two-blade machines isn't insurmountable, however. The AWT-26 handles it with a teetering mechanism, a pin-and-damper system like the ones used on helicopter rotors. The mechanism equalizes wind forces by allowing the blades to tilt slightly, like the two ends of a see-saw tilting around its central pin.

The AWT-26 turbine spins at 57 rpm, about twice as fast as the three-blade Z-40 [see "Trusty as a Tractor"]. And unlike some three-blade designs, the blades of the AWT-26 have a fixed pitch—they don't pivot at the hub. Instead, the wood-epoxy blades flex as wind speed increases, until they stall. But because the airfoil has a different shape at the blade's root than at its tip, the root section stalls earlier than the tip. That lets the blade extract the maximum amount of power from the wind before it completely stalls.

The advantage of this blade design is that it requires no bearings or motors. The AWT-26 also guards against overspeeding with a tip brake, which looks like a small wind vane attached to the end of each blade. If the blades start spinning too fast, the centrifugal force automatically rotates the tips into the wind to slow the turbine.

Robert Lynette, chief designer of the AWT-26, is now working on a larger version that will be erected in Tehachapi, Calif., and in India. The 27-meter AWT-27 turbine will be optimized for low wind speeds.—*D.S.*

for aircraft, which fly high enough to avoid insects most of the time. But roughening of a turbine blade's leading edge can substantially reduce lift and increase drag. The new shapes developed at the Colorado lab minimize the energy losses for bug-spattered blades.

The Renewable Energy Lab is also funding the development of new turbine designs. The goal of the lab's Next-Generation Turbine program is to develop machines by the year 2000 that will generate electricity at a cost of four cents per kilowatt-hour at sites with only moderate wind speeds—an average of 13 mph at a height of 30 feet.

One way to capture more energy at lower wind speeds is to use longer blades and taller towers. As a turbine's blades increase in length, its power output rises exponentially.

"Over the last decade, you can trace the increasing size of wind machines," says Randall Swisher, executive director of the American Wind Energy Association. The machines installed in the early 1980s had capacities of about 40 to 50 kilowatts, not much more powerful than a farm windmill. Today, wind turbines typically generate 300 to 500 kilowatts apiece.

The largest U.S. machine is the 500-kilowatt Z-40 (the number stands for the rotor diameter in meters) made by Zond. Modeled after sturdy farm equipment used in Europe, a single Z-40 can produce enough electricity to power 150 to 200 homes [see "Trusty as a Tractor"]. Zond has tested two prototypes of its Z-40 in Tehachapi, Calif., which could well be called the wind capital of the world. There are more than 5,000 turbines arrayed along the ridges of Tehachapi Pass, where cool air rushes through the mountains to replace hot air rising from the Mojave Desert. Standing atop one of these ridges, you can see more than a dozen different types of wind turbines whirling in the breeze.

Cost considerations will probably keep wind turbines from growing too much larger than the Zond machine. "At some point, the bearings and other components become so big that non-standard parts are required," says Karas. Jumbo turbines also mean oversize cranes and shipping containers.

Zond's proposal for the Columbia River Gorge would put 50 Z-40 turbines on Oregon's Sevenmile Hill in 1996. Across the river, in Washington, a consortium of small public utility districts plans to equip its wind power plant with small, lightweight turbines designed by Seattle-based Advanced Wind Turbines. Representing a different school of turbine thought, the designers of the AWT-26 opted for brains over brawn. While the Z-40 is built like a tractor, in keeping with the European tradition, the AWT-26 embodies an American predilection for aerodynamic engineering [see "Out of Aircraft"].

FloWind Corp. of San Rafael, Calif., which sells the AWT-26, is also working on a new turbine that looks like a giant eggbeater. The advantage of this vertical-axis design is that the extruded aluminum blades can capture wind from any direction. Also, heavy components like the gearbox and generator can be placed on the ground rather than atop a tower. The disadvantage is that the winds near the ground are usually weaker than the winds at the top of a tower.

The only company making such vertical-axis wind turbines, FloWind has installed more than 500 in California. The company stubbornly refuses to give up on the design, and many engineers say it is not inherently inferior to horizontal-axis turbines. "I think it's going to end up being a site-specific thing," says wind energy program manager Sue Hock of the National Renewable Energy Laboratory.

FloWind is currently developing a new vertical-axis turbine called the EHD, short for Extended-Height-to-Diameter ratio. In essence, the company is "stretching" its turbine to reach the winds at higher altitudes. The new design also allows denser turbine spacing.

Vertical-axis turbines aren't the only wind machines that don't look like traditional windmills. Over the years, dozens of alternative designs have been proposed, and some are still being built. Among the most bizarre ideas is the installation of small turbines in highway median barriers to take advantage of the wind created by

Copyrighted material

passing vehicles. Another proposal would mount large turbines at the base of a 3,300-foot-tall cylindrical tower erected in a desert near the sea: Saltwater sprayed into the tower would cool as it evaporated, creating a downdraft to drive the turbines.

Even among conventional windmill-style turbines, there are variations in size, number of blades, and orientation to the wind. The rotors on modern turbines are typically located upwind of the tower. Sensors tell the machine which direction the breeze is coming from, and a motor automatically rotates the turbine to face the wind.

A few machines like the AWT-26 have a downwind orientation. These machines are simpler and less expensive, because they eliminate the sensors and motor needed for pointing a turbine into the wind. But the blades of the AWT-26 are more vulnerable to fatigue, because they must pass through the tower's "wind shadow" on every rotation. Engineers have attempted to minimize this problem by mounting turbines on narrow, flexible towers: One version uses a slender tube anchored with guy lines. Another has a tubular tower wrapped in a Slinky-like spiral structure that helps break up the wind shadow.

But even these measures can't eliminate the noise produced as each blade passes through the tower's wind shadow. It sounds like a giant bullwhip swishing through the air.

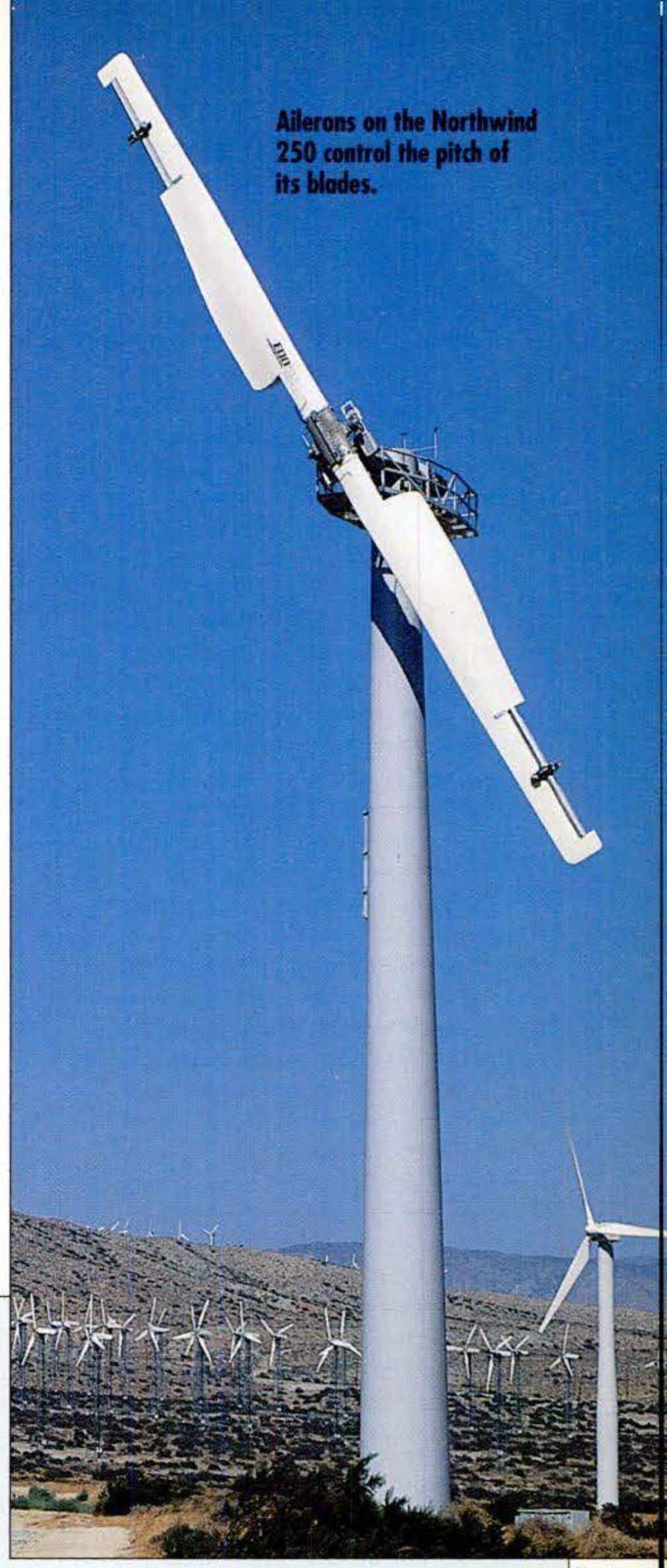
The design for the Northwind 250 turbine eliminates this problem. Created by New World Power Technology Co. of Moretown, Vt., the Northwind will be a 250-kilowatt turbine with a motor that yaws the rotor into the wind. "We thought that the penalties for the tower shadow and noise were greater than the cost penalties for the yaw drive," explains company president Clint (Jito) Coleman. Like the AWT-26, the Northwind turbine takes advantage of aerodynamic principles for more efficient operation and uses a two-blade, teetered design [see "Flying a Turbine"].

Ultimately, the success of lightweight turbines like the AWT and Northwind will depend on how reliable they prove to be in the field. "The question is whether more pounds in the air, or more sophistication, will win," says Coleman. "It's a lot easier to make something heavier and stronger than to work out all the details for a teetered machine."

While New World's Northwind and Advanced Wind Turbine's AWT use sophisticated aerodynamics for cost savings, Kenetech Windpower of San Francisco looks to sophisticated electronics. Kenetech's turbine, the most efficient on the market, relies heavily on electronic controls. Called the KVS-33, it's a variable-speed machine with a rotor diameter of 33 meters, or about 108 feet. Variable-speed machines have been around since the mid-1980s, but Kenetech's is the first to be widely accepted by utilities.

The KVS-33 is more efficient than comparable constant-speed machines because its rotor speeds up or slows down to match shifts in wind velocity. The twin generators produce alternating current with a range of frequencies, rather than the precise 60Hz of the U.S. power grid. A power-control system rectifies the fluctuating alternating current to direct current and then inverts it back into 60Hz alternating current.

Kenetech also uses advanced electronics to operate the KVS-33. A controller monitors wind gusts and other conditions and automatically adjusts each turbine. Individual turbine controllers report to a central computer that keeps track of utility load requirements. For example, a station located at Altamont Pass in Northern California controls not only nearby turbines but also others in Southern California and Minnesota.



Ailerons on the Northwind 250 control the pitch of its blades.

JOHN B. CARNETT

FLYING A TURBINE

Taking a cue from evolution, the two-blade, 250-kilowatt Northwind 250 turbine adopts some of the aerodynamic flying techniques of birds.

The blade design is "like a bird's wing," says engineer Garrett L. Bywaters of New World Power Technology Co. of Moretown, Vt. "A vulture doesn't twist its whole wing while flying," he explains. "It just moves the feathers at the tip of the wing." Likewise, the Northwind turbine is "flown" by adjusting a small aileron near the tip of the blade's trailing edge, rather than by moving the entire blade.

Unlike the aileron on the much larger Zond turbine, which is only used for braking in gusts [see "Trusty as a Tractor"], the Northwind aileron actually controls the pitch of the blade while it is moving. "As you deploy the aileron, the lift goes down and the drag goes up," says company president Jito Coleman.

New World plans to build five Northwind prototypes this year, and will begin production by 1997. But a full-scale proof-of-concept model at San Gorgonio Pass in Southern California shows some of the new technologies that will eventually be incorporated, including a "flow-through rotor." The blades of a conventional rotor are made separately, then bolted to a steel block with flanges. However, the Northwind's two fiberglass blades form a single piece from tip to tip. A saddlelike aluminum clamp fits over the center of the rotor, with a rubber bearing separating the aluminum and fiberglass. By eliminating the flange at the root of each blade, New World saves 25 percent of the blade's cost.

The companies that make rugged, European-style wind machines "have won the first round, hands down," concedes Coleman. But he believes that lightweight, teetered machines like the Northwind will eventually prevail—especially as turbine size increases. "The bigger the machine, the more cost savings you can get from sophistication," he says.—*D.S.*

Copyrighted material

BIRDS AND BLADES

Wind turbines may be less environmentally harmful than nonrenewable energy sources, but they aren't a panacea—they kill birds.

Turbine operators first noticed the "avian mortality" problem at Altamont Pass, east of San Francisco. While birds of many species are killed by turbines, the most numerous and conspicuous casualties are raptors—birds of prey such as the golden eagle, the red-tailed hawk, and the American kestrel.

Nobody knows exactly how many birds collide with the plant's 7,000 turbines, because coyotes and other scavengers snatch most carcasses before they can be counted. But a 1992 study calculated that as many as 567 raptors, including 78 golden eagles, may have died at Altamont Pass during a two-year period.

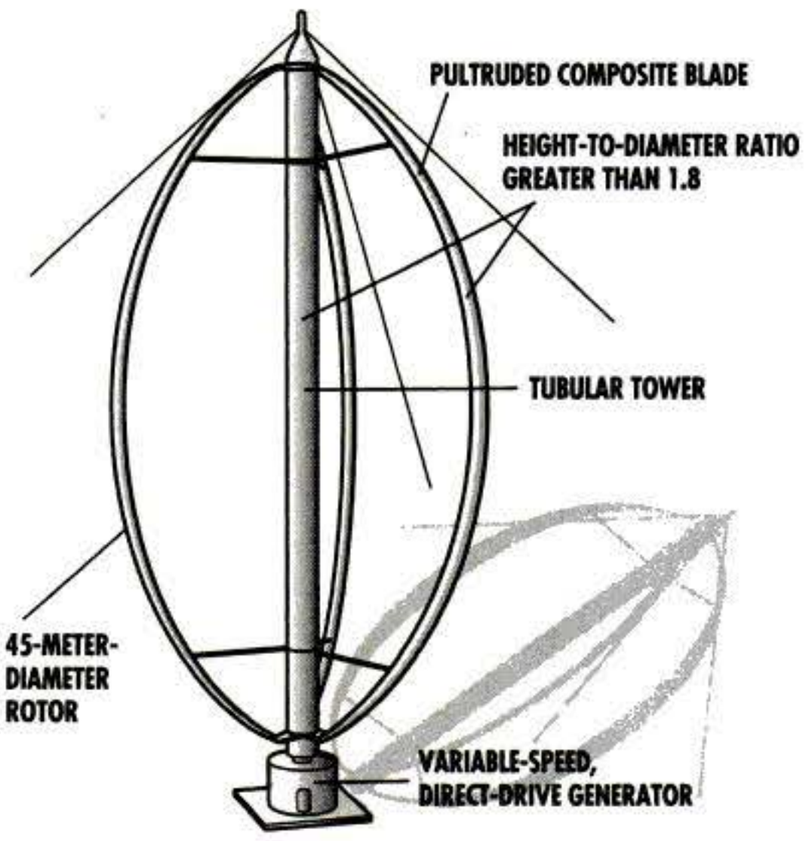
These numbers pale in comparison with the estimated one million birds electrocuted annually by power lines, or the 500,000 killed in oil ponds. Nevertheless, the death of just a few rare birds can spell doom for a species.

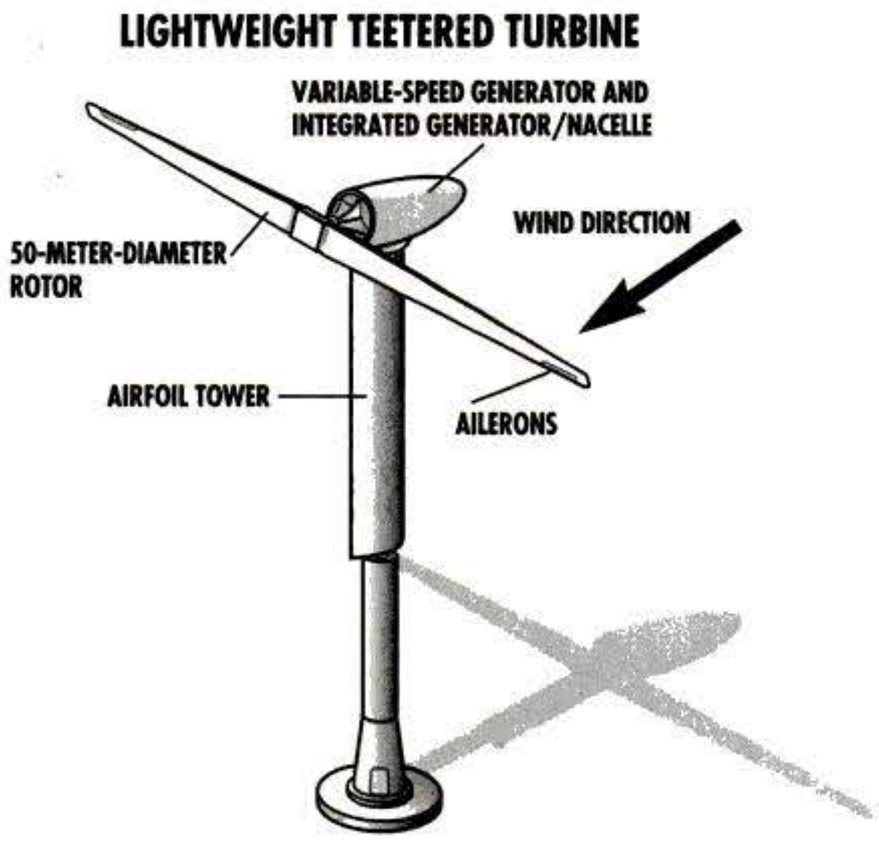
Kenetech Windpower, which operates many Altamont turbines, has already spent $2 million to study avian mortality. One objective is to develop procedures for siting wind plants away from flyways. The company hopes to learn why most other wind plants have fewer raptor fatalities than Altamont.

Kenetech is also studying techniques to frighten birds away from turbines, such as eyespots or stripes painted on the blades. Other researchers sponsored by the Electric Power Research Institute are experimenting with a radio-signal device that appears to deter pigeons in laboratory tests. Replacing truss towers with tubular versions may also discourage perching. The tubular models are typically twice as expensive, however.—*D.S.*

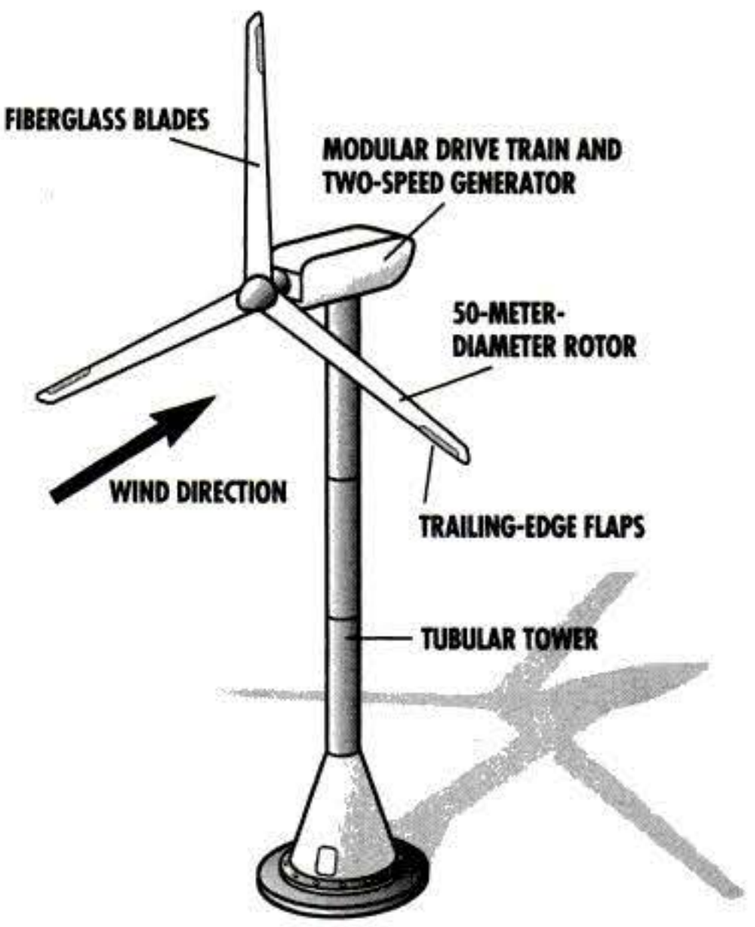
Federal law prohibits the killing of golden eagles.

TONY STONE IMAGES





Experts predict these three turbine types will appear around the year 2000. The propeller-like turbines (below) generate 800 kilowatts, and the eggbeater-style (left), one megawatt.



KERR ILLUSTRATION

The KVS-33 went into production three years ago, and 577 of the machines had been manufactured by the end of 1994. Kenetech expects to build another 900 this year. The company hopes to erect as many as 345 KVS-33s in the Columbia River Gorge during the next few years.

The gorge could soon become a battleground for the three design approaches represented by the Zond, AWT, and Kenetech turbines. But already, the technologies in these different designs are converging as engineers begin devising turbines for the 21st century. European machines have begun losing weight, American machines are putting on pounds, and virtually every wind company is working on a variable-speed control system for its turbines. The German company Enercon has also developed a 500-kilowatt turbine with a direct-drive generator—instead of a gearbox, it has a huge ring generator coupled directly to the rotor's drive shaft.

Wind experts at federal laboratories predict that the turbines entering the market in five years will be larger and lighter than those used today. They will have 200-foot-tall towers, advanced airfoils, variable-speed operation, and direct-drive generators. The experts see room for at least three different configurations of "dream machines" in the marketplace of the year 2000 [see drawings].

As turbine size and efficiency increase, the cost of wind power is expected to continue dropping. Since the early 1980s, the price of electricity from wind has plummeted by more than 80 percent. The average cost is now between six and nine cents per kilowatt-hour, but the wind plants that will go online this year will sell electricity for as little as 3.9 cents per kilowatt-hour. That's competitive with prices for oil, coal, natural gas, and nuclear energy, and nearly as low as prices for hydroelectric power. And, experts say, wind development creates more jobs per dollar invested than these other energy sources.

If the cost of conventional energy sources, such as oil, included surcharges for air pollution, wind power would look like quite a bargain. But even without these considerations, wind has quietly gained ground on its nonrenewable rivals.

Wind power has advanced to this point even as tax incentives for its development have dwindled. Substantial tax credits, especially in California, gave the industry a jump-start in the 1970s and '80s. But all that's

[*Continued on page 85*]

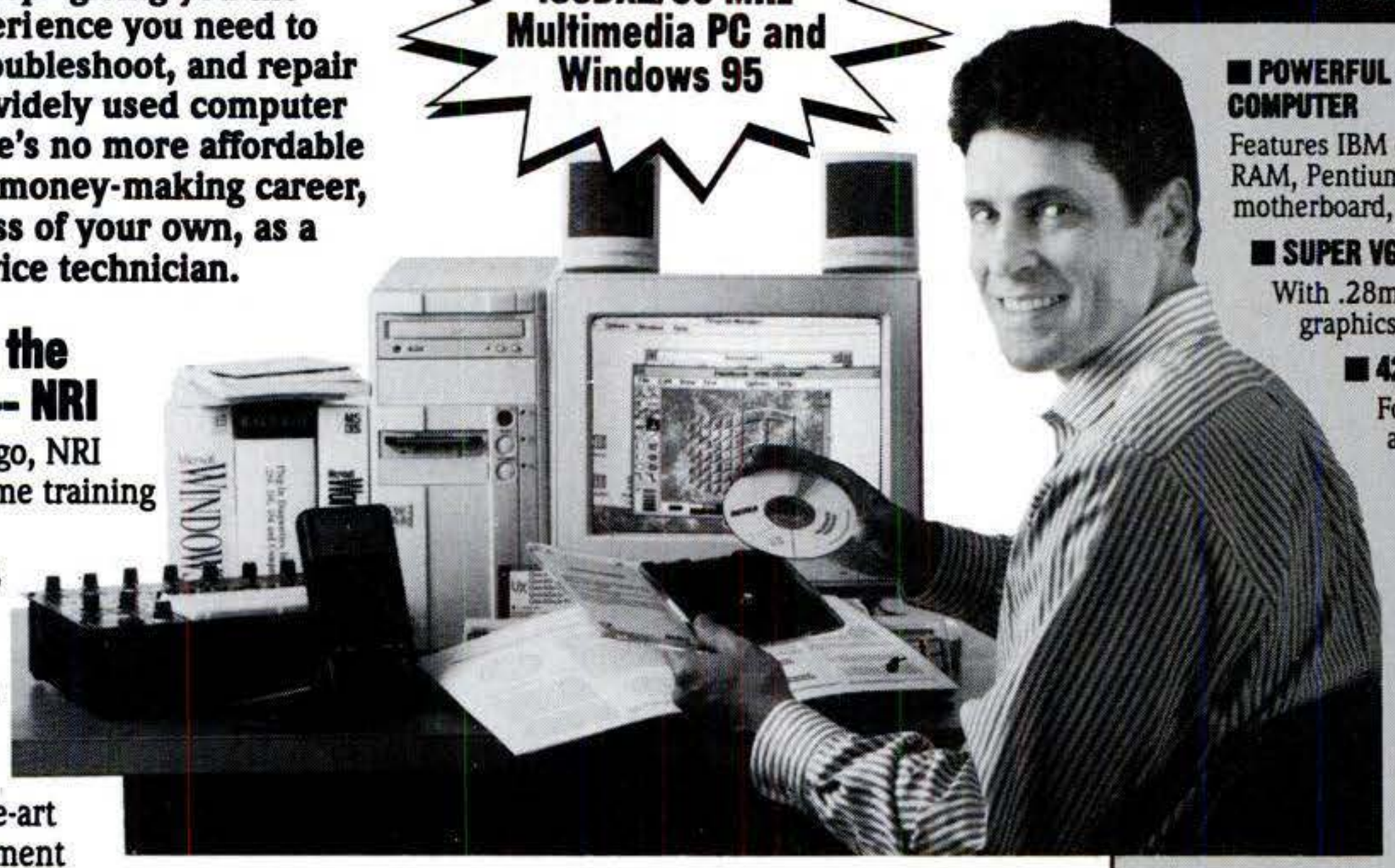
Copyrighted material

Be a high-paid computer service technician

Train With NRI — America's #1 Choice in Computer Training

Only NRI gets you inside a powerful 486DX2/66 MHz Intel-based computer system you keep–giving you the hands-on experience you need to work with, troubleshoot, and repair today's most widely used computer systems. There's no more affordable way to start a money-making career, even a business of your own, as a computer service technician.

NEW! 486DX2/66 MHz Multimedia PC and Windows 95



Rely on the original -- NRI

Over a decade ago, NRI pioneered at-home training in computer servicing. Today, NRI offers the *only* computer servicing course with real-world experiments using state-of-the-art computer equipment and professional diagnostic tools.

There's no doubt about it: Working "hands-on" with all the most sought-after technology gives you practical skills and lasting confidence. Performing key tests and demonstrations, you're able to see for yourself how things work, what can go wrong, and how you can fix it.

Train with and keep the most advanced computer in home study today

NRI's unique training has you explore a top-notch computer system and its peripherals, beginning with the 486DX2 Intel CPU and Pentium Overdrive-ready motherboard.

Your computer features 8 meg RAM, 420 meg hard drive, and fax/modem to store, receive, and send huge amounts of data.

You'll also appreciate the brilliant display of your Super VGA color monitor, the drama of your CD-ROM drive and 16-bit sound card, as well as the cutting-edge technology of Windows 95.

Plus learn to use Ultra-X professional diagnostic hardware and software to pinpoint problems on any IBM-compatible machine.

No experience needed, NRI builds it in

Studies show that jobs for computer service technicians will be up by 38% in the next 10 years. Even if you've never worked with computers before, NRI's interactive training builds such a solid foundation of know-how and practical experience that tomorrow's jobs can be yours.

Right from the start, hands-on experiments reinforce concepts presented in NRI's bite-sized lessons. And because your work is reviewed by your personal instructor, you know for certain that you can apply theory to real-world demands.

FREE NRI catalog tells more

Send today for your free, full-color catalog describing every aspect of NRI's innovative computer training in the up-and-coming field of your choice.

YOU GET EVERYTHING YOU NEED FOR SUCCESS

■ POWERFUL 486DX2/66 MHz INTEL-BASED COMPUTER
Features IBM compatibility, 8 meg RAM, Pentium Overdrive-ready motherboard, and math coprocessor

■ SUPER VGA COLOR MONITOR
With .28mm dot pitch for high-resolution graphics and tilt-swivel base

■ 420 MEG HARD DRIVE
For greater data storage capacity and data access speed

■ EXCITING MULTIMEDIA PERIPHERALS
Double-speed CD-ROM drive, 16-bit sound card with speakers, and reference CD

■ FAX/MODEM
Gives you access to a world of on-line information

■ ULTRA-X DIAGNOSTIC PACKAGE
R.A.C.E.R. plug-in card and QuickTech-PRO software help you detect problems on virtually all IBM-compatible machines, even if computer is 5% operational.

■ NRI DISCOVERY LAB
Complete breadboarding system lets you design and modify circuits, diagnose and repair faults

■ DIGITAL MULTIMETER
Professional, hand-held test instrument for quick and easy measurements

■ WINDOWS 95
The time-saving operating system that everyone will be using tomorrow

If the coupon is missing, write to: NRI Schools, McGraw-Hill Continuing Education Center, 4401 Connecticut Avenue, NW, Washington, DC 20008.

IBM is a registered trademark of the IBM Corporation. R.A.C.E.R. and QuickTech-PRO are registered trademarks of Ultra-X, Inc.

SEND TODAY FOR FREE NRI CATALOG!

NRI McGraw-Hill Continuing Education Center
4401 Connecticut Avenue, NW, Washington, DC 20008

☑ **Check one FREE catalog only**

❑ Check for details on career courses approved under GI Bill!

❑ **MICROCOMPUTER SERVICING**
❑ Computer Programming
❑ TV/Video/Audio Servicing
❑ Desktop Publishing & Design
❑ LAN Specialist
❑ Bookkeeping and Accounting
❑ Programming in C++ with Windows

Name (please print) _____ Age _____

Address _____

City _____ State _____ Zip _____

Accredited Member, National Home Study Council

0101-0795

Copyrighted material

Just imagine: no jangly coins in your pants, no crinkled bills in your wallet. To buy a soda you simply insert something called a stored value card into the vending machine. A text display above the slot where you once dropped quarters tells you how much is being deducted and the remaining value on the card. You pull out the same card to board a bus, do your laundry, or buy a newspaper. You add value to the card by inserting it in an Automatic Teller Machine. You'll even be able to reload the card over a special telephone—eliminating at last the major encumbrance of home banking: the inability to draw cash. Once e-money is accepted as universally as greenbacks, don't be surprised if a disheveled man on the street steps up to you and says, "Brother, can you spare a little stored value?"

Such is the vision of smart card proponents, who push chip-embedded plastic both as a realistic alternative to cash and a tactile alternative to non-physical digital money that exists only as numbers on the Internet. Smart cards are also referred to as chip cards and electronic purses.

"If we had our way, we'd implant a chip behind everyone's ear in the maternity ward," says Ronald Kane, a vice president of Cubic Corp.'s automatic revenue collection group. Cubic is the leading maker of smart card systems for mass transit systems, highway tolls, parking, and other applications and one of a number of companies and government agencies pushing the frontier of smart cards—the money of the future. For Kane and his colleagues, the next best thing is giving everyone a card—a high-tech pass with a memory that may, sooner than we imagine, replace cash in our wallets.

A smart card goes a step beyond the magnetic strip card, which is basically a memory device, the equivalent of a small computer disk. A true smart card contains a microprocessor. It is in effect a miniature computer, where a recorded balance can be added to or subtracted from. What makes a smart card like cash is that it is a debit card rather than a credit card: It already has value.

Why cards instead of cash or check? Convenience, security, and cost. Money costs money. Handling it, accounting for it, protecting and tracking it is expensive—whether the money is in the form of cash, checks, or credit cards—to the tune of $60 billion a year by one reckoning. Money wears out, as tourists treated to the sight of antiquated bills rolling into a furnace for destruction see on visits to the Printing and Engraving office in Washington. Checks must be handled and stored. Credit cards must be manufactured and billed. The amounts of transactions must be verified by phone.

Today's bills are problematic for vending machines. England has a pound coin, but the Susan B. Anthony dollar coin never caught on here. Modern vending machines accept dollar bills, but users still face the frustration of their money being rejected because of folded corners and wrinkled edges.

One of the great benefits of smart cards is that the card's value can be verified and changed without going through the kind of credit card dial-up system, such as Verifone, found at most retail stores. Transactions can be speeded up, and lines shortened. And although we may not all end up with a chip implanted under our skins, the even smarter cards of the future may be validated "biomorphically" by fingerprints or retinal readers.

At a computer industry gathering in Las Vegas, Microsoft's Bill Gates held out a vision of an "electronic wallet," a kind of miniature Personal Digital Assistant that could be loaded with cash at a terminal, then discharged for purchases of goods and services.

TOM WHITE

Imagine using the sort of smart card planned by Visa in an experimental program for the 1996 Atlanta Olympics. Although final plans are still being worked out, the user could get up in the morning with a card he had loaded with, say, $200 the day before at an ATM-like machine. He pays for breakfast at a fast food restaurant, pays for a bus ride to an Olympic stadium, then purchases a ticket for the pole vault competition at a machine on-site. In the hot afternoon sun, he stops by a vending machine to purchase a cool drink with the card, then pauses at a nearby telephone to call

BY PHIL PATTON

If you thought e-mail changed your life, wait until you get a fistful of this.

Copyrighted material

money

Copyrighted material

home, also using the card. Considering that Americans spend an estimated $1.8 trillion a year in amounts of $10 or less, switching to a smart card system will affect everyone.

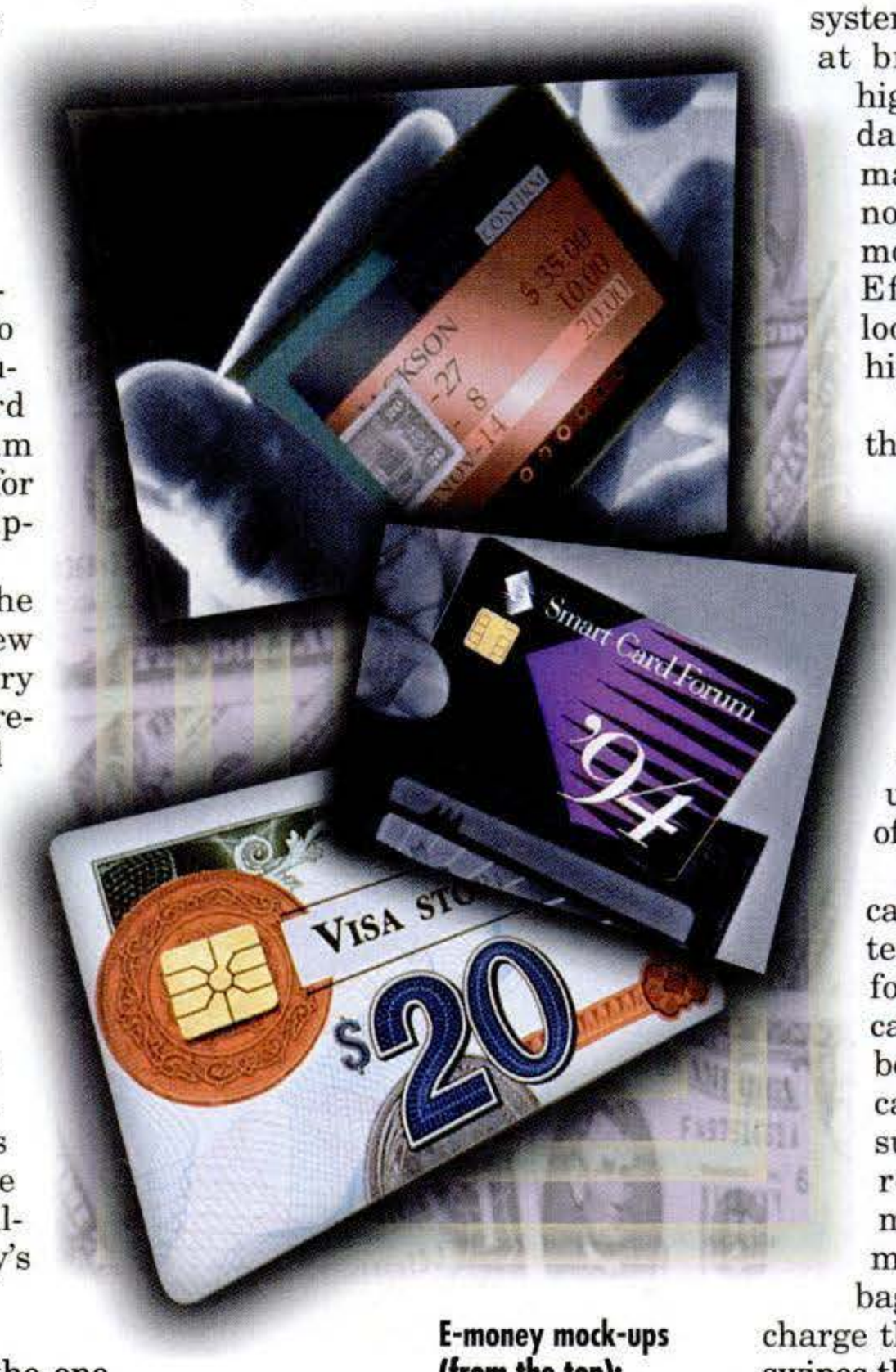
With the value of the card reduced, he might stop at an ATM to add another $100. (One of the virtues of the card is that if it is lost, only its current value is put at risk, and not an entire line of credit.) Or he might exhaust the card's value and simply throw it away. In the Visa experiment, the cards will be disposable.

Converting to smart cards will require massive, but gradual, refitting or replacement of equipment in stores, restaurants, and telephones. The first smart cards will carry the conventional magnetic stripe so they can be used like traditional credit cards in addition to their "smart" functions. The transition will likely be a quiet, almost unnoticed process, smart card proponents say. And it's already happening.

"This technology is sneaking into our lives from the back door, so to speak," says Bob Gilson, executive director of the Smart Card Forum, an industry consortium working to establish standards for the new generation of microchip-equipped cards.

The Smart Card Forum is the most powerful force behind the new cards. The Forum is an industry group made up of leading banks, retailers, equipment makers, and government agencies attempting to produce standards for smart cards as universal as those that exist today for magnetic stripe cards.

Smart cards are moving us toward a cashless society. From basic applications like the magnetic stripe cards for mass transit to visions of digital global transactions on the Internet, the money of the future is likely to be smarter, smaller, and more versatile than today's currency.



E-money mock-ups (from the top): Microsoft's electronic wallet, an ultra-slim Personal Digital Assistant; the Smart Card Forum card shown at a conference; and Visa's stored value card.

In Europe, systems not unlike the one Gates envisioned already exist, such as Denmark's Danmont and a British system, called Mondex, that keeps track of up to five different currencies. Smart cards are already well established there, says Gilson, largely because of Europe's more centralized economies and the greater degree of government involvement and standardization. Here, we are still waiting for private business and government to agree on standards and uses.

Smart card systems proven in Europe are likely to be the basis for our future systems. Because the telecommunications infrastructure is less developed over there and its costs higher, Gilson notes, cards for phone use have become an accustomed way of life.

The entire bank payment system in France, involving 22 million people, has been converted to smart card technology. Germany's health care system uses smart cards for patient information and billing.

Europe is more familiar with the concept of debit cards (pay in advance) than with credit cards (pay later), which are the American norm. And while most credit cards here are verified with a central computer through systems such as Verifone, the comparatively high cost of telephone service in Europe has helped smart cards flourish there as an alternative to the retail systems that must dial up a central service for credit authorization.

In the United States, the change to smart cards, like so many technological changes in the past, seems likely to creep in on the little feet of the mundane. Smart cards will arrive first for such simple applications as magnetic strip telephone cards or mass transit cards. New York City's subway and bus system now uses one of Cubic's systems, as does London's famed Underground, along with mass transit systems in Washington, Chicago, Atlanta, and Singapore.

Cubic is also experimenting with systems that take automobile tolls at bridges, tunnels, and along highways. Agreement on standards for such a system was mandated under ISTEA (pronounced "ice tea"), the Intermodal Surface Transportation Efficiency Act, which also looked toward creating smart highways for the future.

Such systems can pay for themselves quickly—but only if personnel costs are reduced—often a politically difficult thing to achieve. The fare cards automatically provide detailed information about ridership—the number of people using each station, the times of greatest use, the distance and direction of trips.

An example of a simple smart card for the future is the "extended utility" plan in the offing for New York's subway fare card. In this vision, a card will be loaded with cash value that can be expended not only on subway and bus fares but on retail purchases. The commuter heading for his train might be able to pick up a bagel, coffee, and newspaper and charge them to the same card that he swipes through the turnstile.

Such uses, however, may soon have to compete with more universally accepted cards—smart credit cards such as Visa.

After years of looking at various new technologies, credit card firms are only now beginning to move into the world of smart cards. In the next year, Visa and Mastercard are beginning their first experiments with smart cards. Mastercard is launching its effort in Australia. In the planned program built around the 1996 Summer Olympics in Atlanta, Visa is teaming up with three Southeastern banks. Some 300,000 cards will be issued in an effort that is likely to have profound effects in publicizing the technology.

A number of smart card systems are already in place, most with controlled groups of users. Visa has tested some of its future cards on employees in its headquarters outside San Francisco. In cafeterias at some of America's leading banks, future smart cards are being tested in pilot

[Continued on page 83]

Copyrighted material

Quest for the Boojum

A trek through the cactus gardens of Baja California in the ultimate off-road vehicle.

BY STUART F. BROWN

It sounds Australian. Its appearance—a towering, leafy rat's tail—suggests something from the pen of Dr. Seuss. Both wrong. Boojum trees are real, though rare. And they are found in certain regions of Baja California, the western Mexican peninsula that juts 800 miles south into the Pacific Ocean.

Finding the boojum tree became a fixation as I flipped through books on desert wildlife in anticipation of a trek through the remote and rugged Baja backcountry. The boojum's droll moniker and primeval appearance qualified it as a special quarry to pursue, a botanical unicorn.

Last spring, record rains transformed large areas of normally parched Baja into a riot of blooming cactus and wildflowers. A fine carpet of tender vegetation sprouted from the desert floor, making the terrain look like a garden tend-

JOE POCIMENI

A forest of spindly boojum trees rises behind a muddy, four-passenger Hummer. Overhanging plants such as the needle-tipped agave at left made it wise to keep the windows rolled up.

ed by meticulous caretakers. It's a stirring transformation if you are lucky enough to witness it. A few rainless weeks later, the scorching sun would turn most of the greens back to browns, and the rare zenith of verdure would be a memory.

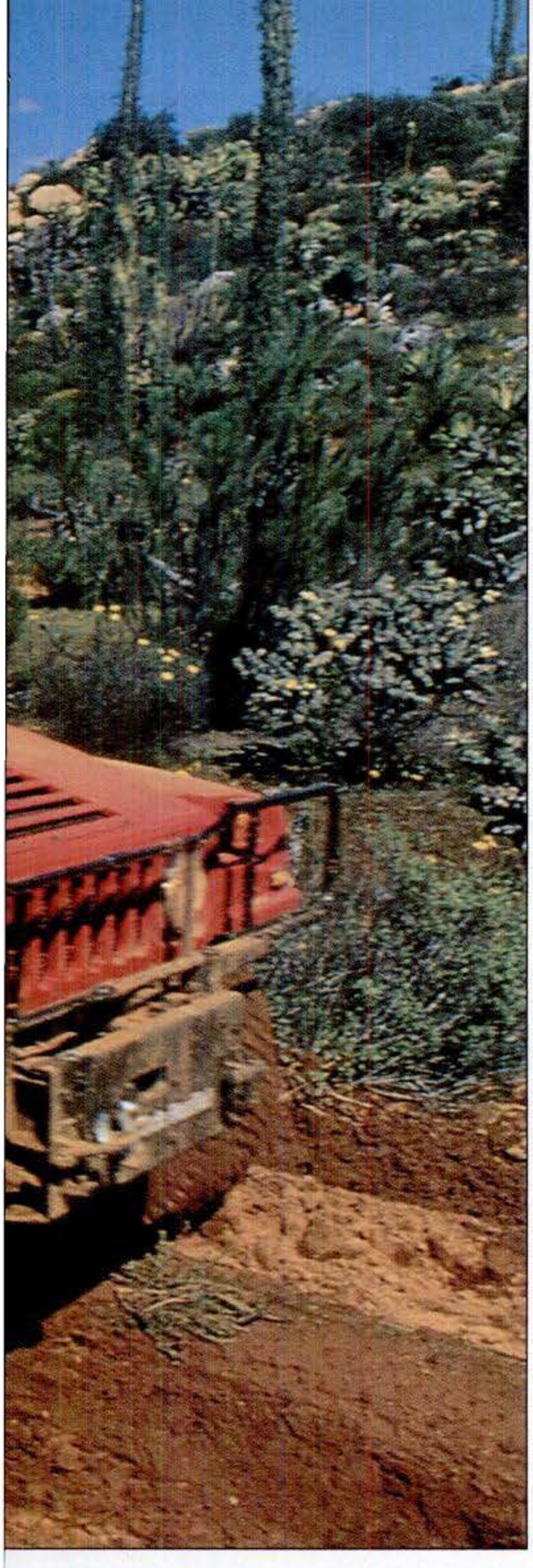
Aside from straddling a burro or a serious dirt motorcycle, the only way to reach some of the remote stands of boojum and unique cacti indigenous to Baja is with a civilian version of the Hummer, the military-utility vehicle built by AM General Corp. of South Bend, Indiana. Garden variety four-wheel-drive sport-utility vehicles and pickup trucks begin to drag their axles and differentials when dirt roads dissolve into rocky stream beds, then into micro-canyons—and it's time to turn around. Here the Hummer can press on regardless, due to its capable drivetrain and lofty 16-inch ground clearance, about twice that of most four-wheelers.

Known for its role in the Persian Gulf War and in the driveways of celebrity showoffs, the wide-track Hummer is the product of one of those "military specifications" that sometimes spawn procurement horror stories. In this case, though, the Army paperwork merely said what the truck should do, without prescribing every last nut and bolt.

Among other things, the high-mobility multipurpose wheeled vehicle (HMMWV, or humvee in milspeak) had to be able to climb a 60-degree grade without bogging down and stably traverse a 40-degree side slope—while carrying a two-ton payload. Engineers were free to find their own design solutions, and the military ended up with an almost unstoppable rough-terrain vehicle that's easy to drive and difficult to roll over. Somewhere along the way the Hummer nickname attached itself to the truck. For more information on the Hummer's unique technology, see "Under the Skin of the Ultimate Off-Road Machine."

A rich fund of knowledge exists about Baja "roads" and smashed vehicles. In 1967, desert-racing enthusiasts organized the first Mexican 1000, a brutal event that was run at breakneck speed along the nearly 1,000 miles of mostly unpaved road connecting Tijuana with the tropical

Copyrighted material



JOE POLIMENI

port city of La Paz near the peninsula's southern tip. In those days, entrants included modified Volkswagen Beetles of all descriptions, Toyota Land Cruisers with Chevy V8 motors, and even a Rambler American sedan. Dirt bikers rode in the event too.

This spring I retraced major sections of the original Mexican 1000 route, driving both diesel- and gasoline-powered Hummers in a paramilitary operation commanded by off-road racer Rod Hall, who has won the event 13 times and is the sole veteran of the 1967 race still showing up at the starting line. My Hummer experience included hardtop and canvas-roofed versions configured with seating for two or four passengers, plus substantial cargo storage. We were mechanically self-sufficient, packing along a supply of spare wheels and other wear-and-tear parts. Periodic liaisons with a 40-foot flatbed truck carrying 2,000 gallons of diesel fuel and gasoline in four portable tanks kept the Hummers nourished.

Wind, rain, and road construction have gradually changed Baja's complexion, leaving remote bypassed sections of the old race route to the forces of erosion. Sections of it have become truck hell, winding through cactus heaven.

During the first two days of my hard-driving, four-day off-road journey from San Quintin in the north to La Paz in the south [see map], we more than once climbed into thickening stands of boojums—just like the ones in my books. Like most desert plants, the big woody shrubs flourish at a specific elevation that suits their temperature and humidity preference. Distinct bands of specialized flora give the hilly terrain of desert Baja a layer-cake appearance.

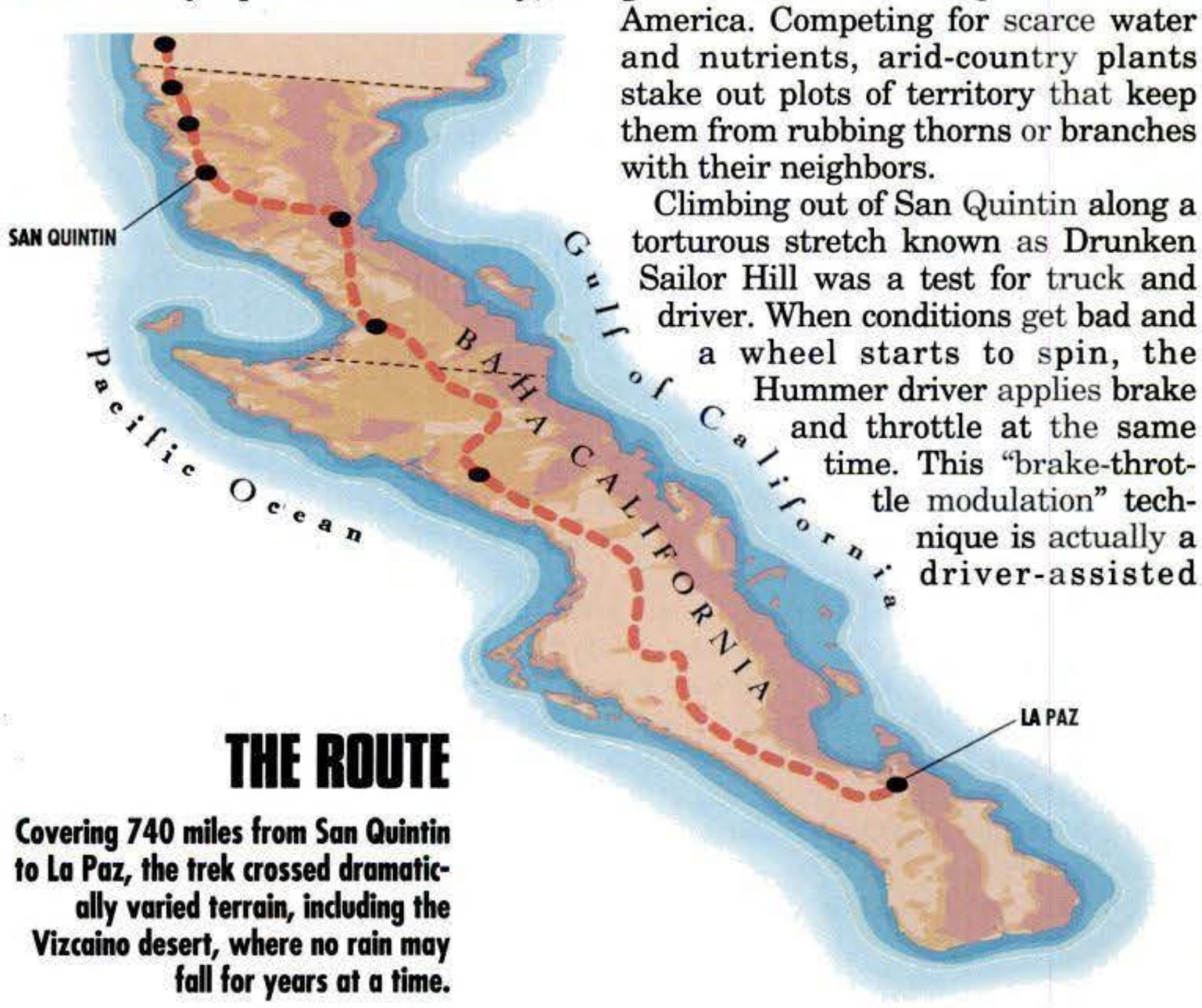
Ascending for the first time into the boojum stratum, I called on the citizen's band radio for an urgent pit stop. It was really an excuse for a stroll through the moist, bloom-perfumed air this year's pronounced El Niño weather condition had brought to Baja. The recurring climatic event caused the northern jet stream to split; its serpentine lower fork herded drenching storms generated by warm southern-Pacific waters eastward across the normally arid peninsula [see "El Niño: The Weathermaker," May].

Tall, thorny, and jacketed with freshly sprouted leaves, some boojums were branched, while others consisted of a solitary spike. Occasionally, I spotted a quirky renegade that traced a question mark against the sky. Often, the boojums grew in mixed forests with the saguaro-like cardon, Baja's tallest cactus. "Forest" is the correct term for a number of large plants grouped together. But the low density of a desert forest makes it look sparse to eyes accustomed to the junglelike woods of temperate North America. Competing for scarce water and nutrients, arid-country plants stake out plots of territory that keep them from rubbing thorns or branches with their neighbors.

ROBERT G. WURTZ

The towering cardon cactus is common in Baja and can weigh as much as ten tons. Locals use dried ribs from the plant's skeleton to make fences, fish spears, and rafters for houses.

Climbing out of San Quintin along a torturous stretch known as Drunken Sailor Hill was a test for truck and driver. When conditions get bad and a wheel starts to spin, the Hummer driver applies brake and throttle at the same time. This "brake-throttle modulation" technique is actually a driver-assisted



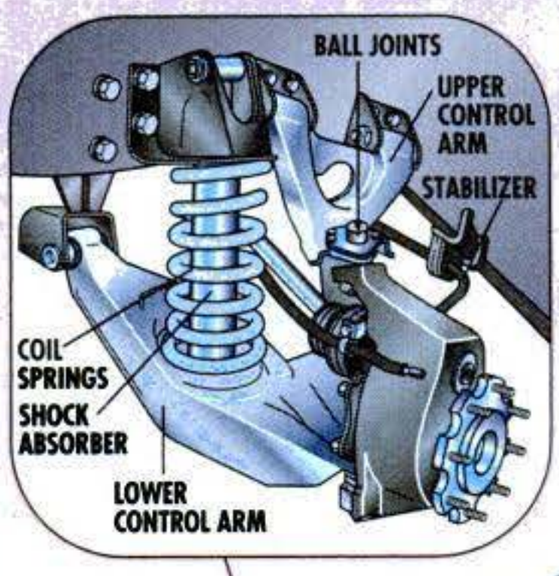
GERALD R. RUSSELL

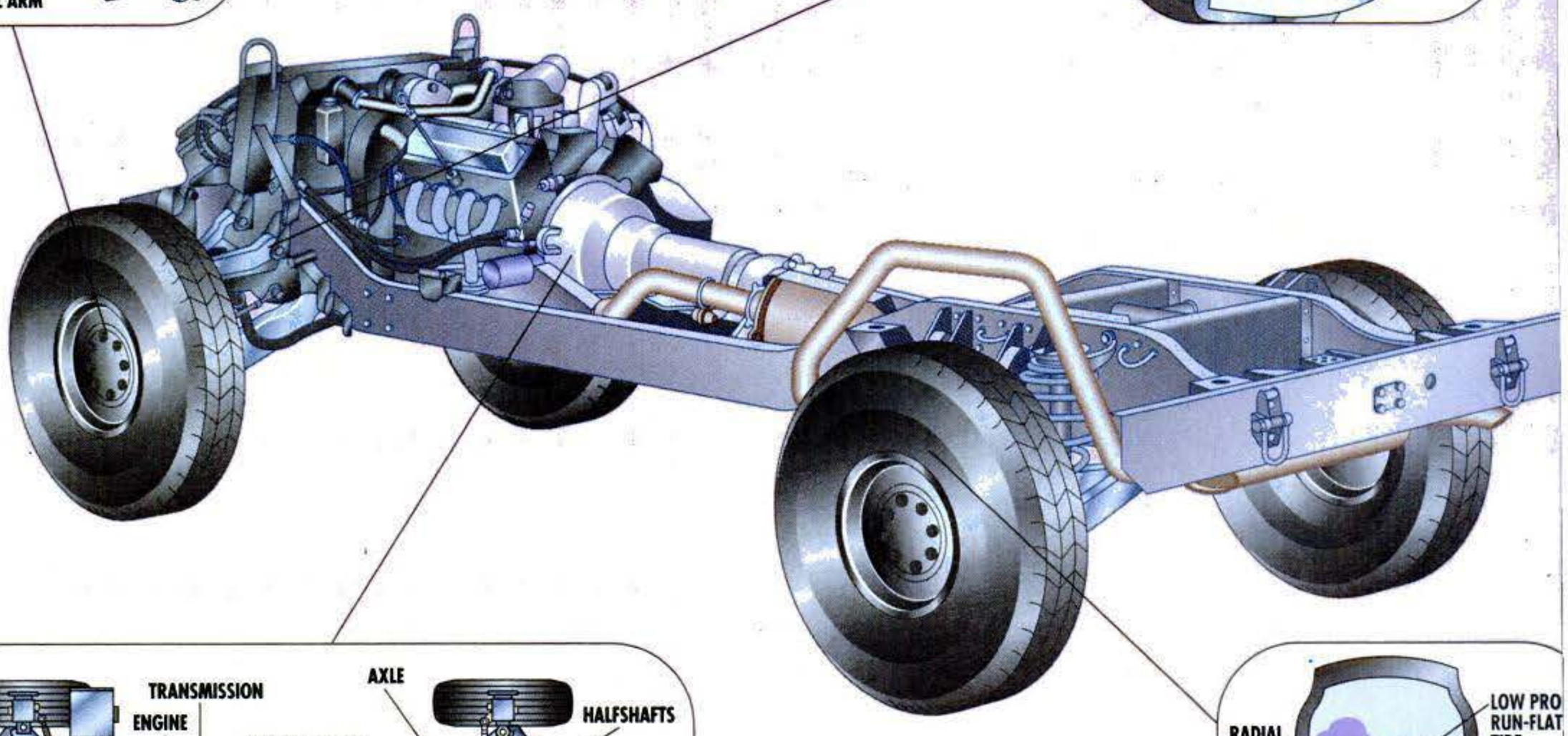
THE ROUTE

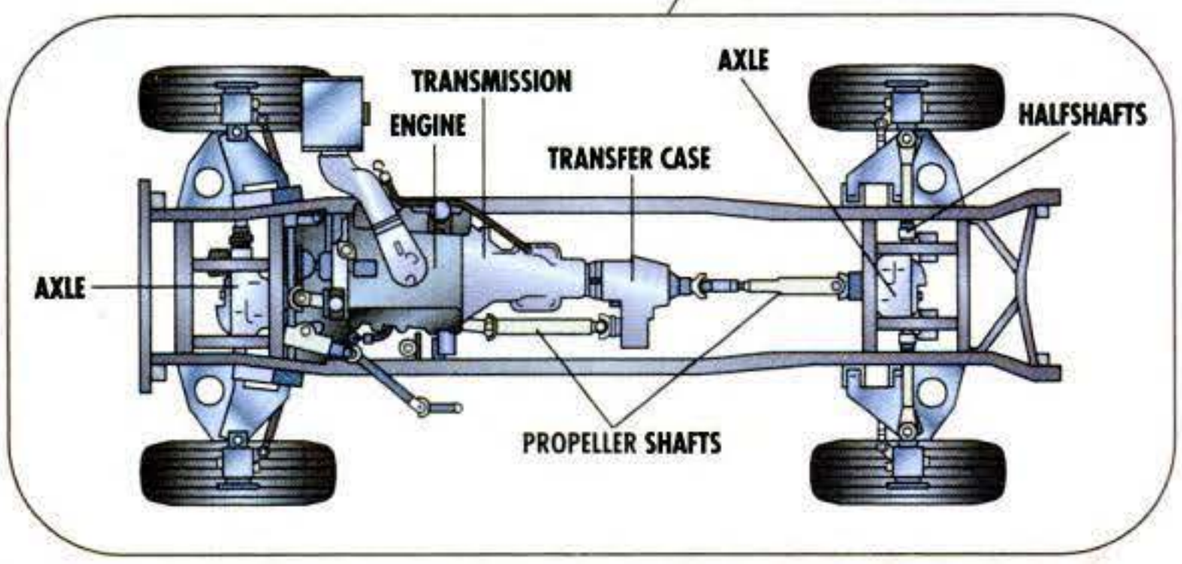
Covering 740 miles from San Quintin to La Paz, the trek crossed dramatically varied terrain, including the Vizcaino desert, where no rain may fall for years at a time.

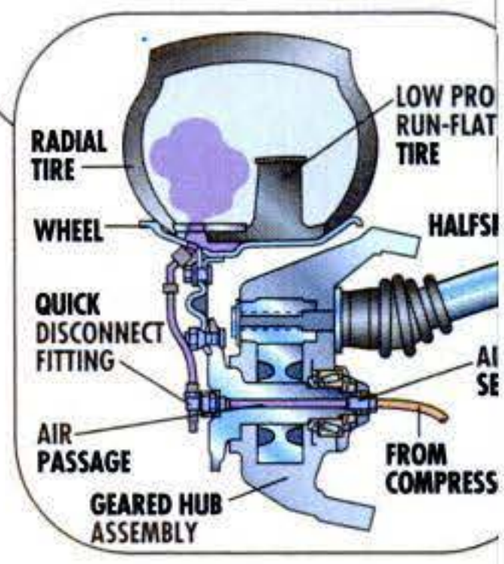
Copyrighted material

UNDER THE SKIN OF THE ULTIMATE OFF-ROAD MACHINE









Beneath the boxy expanses of the Hummer's skin reside working parts conceived from the outset to operate in truly rough country. Designers began by locating the entire drivetrain—engine, transmission, driveshafts, and differential gearcases—out of harm's way above the lower edge of the box-section steel frame. Disc brakes are mounted inboard, racing-car style, next to the differentials, where they are shielded from damage.

The Hummer's interior hosts a big central "doghouse" covering the high-mounted drivetrain hardware, but the truck's wide track and well-distributed weight keep its center of gravity low. Thus, tippiness isn't a problem. Military versions exploit the doghouse as a mounting point for machine guns or antitank weapons.

Using independent suspension at all four wheels avoids the ground-clearance limitations of the rigid axles found in most four-wheelers. Final drive is through geared hubs that reduce halfshaft speed by a ratio of about 2:1 at each wheel. This final multiplication of torque right at the wheels greatly decreases stresses on the driveline and permits the use of lighter-weight components. The halfshafts connect to the top of the geared-hub housings, where they are protected from marauding rocks by heavy suspension A-arms.

MARIO FERRO

A secondary benefit derives from the geared-hub arrangement: Because the center of the hub is unoccupied by the usual halfshaft and universal joint, an onboard tire-inflation system becomes easy to design. The Hummer's central tire-inflation system isn't a silly techno-selling feature of the sort that sprouts on luxury cars from time to time, however.

Adjusting tire pressure on the go from 15 psi in soft sand to 30 psi on asphalt to obtain the best traction and handling bolsters the Hummer's effectiveness as a military vehicle and helps any user make optimal progress across changing terrain. What keeps the air hoses running through the hubs from twisting themselves to death? Special rotating couplings sealed with O-rings let the wheels turn, but not the hoses.

Wars draw armies into horrendous conditions for wheeled transportation. Remote oil drilling, mineral exploration, and ranching ventures place civilians in similar circumstances, where Hummers perform impressively. Though almost nobody else really needs one, a certain number of affluent commuters shell out $40,000 to $57,000 to be seen in the tough, broad-shouldered Army truck that's cooler than a Range Rover. Although actual mileage may vary, as they say, the Hummer's fuel consumption ranges from about nine to 15 mpg for the diesel version, and approximately six to 12 mpg for the thirstier gasoline model.—*S. F. B.*

Copyrighted material

traction-control strategy that stops the spinning wheel and redirects torque through the front and rear differentials to the wheels with good bite. Growling up the hill, the Hummer readily powered out of deep gullies and sand holes using the modulation trick.

Hummers come with a 6.5-liter General Motors V8 diesel engine that produces an abundance of mud-defeating torque. A gasoline-fueled 5.7-liter GM V8 is now offered for those who don't like diesel clatter or aren't near a fuel source. But the standard motor's effortless pulling power makes it the better choice for the Hummer's intended rough-country mission. The Army wanted the truck to be simple to drive, so full-time power is sent to all four wheels through a heavy-duty four-speed automatic transmission.

When driving fast in high range across sandy ground, the transmission can be set in a mode that locks the center differential to equalize front and rear axle speeds, reducing the tendency of four-wheel-drive vehicles to weave slightly left and right. I appreciated this benefit as I picked up speed through soft, silty soil, as fine as talcum powder, which flattened out into temporarily rain-soaked dry lake beds. At times like these, I used the Hummer's central tire deflation/inflation system to bleed pressure down to a mushy 15 psi that greatly enhanced soft-ground traction and steering. On paved roads, pumping the tires back up to 30 psi delivers the best handling and fuel mileage.

Real off-road racers, by the way, would never use this sissy differential-locking feature. They want their vehicles to be twitchy so they can throw them sideways at more than 100 mph to lose speed in turns, throw dust in the face of the competition, and get there first. From time to time I observed veteran Baja terror Rod Hall, a composed and compact man. Our pace, I suspected, probably felt to him more or less like standing still.

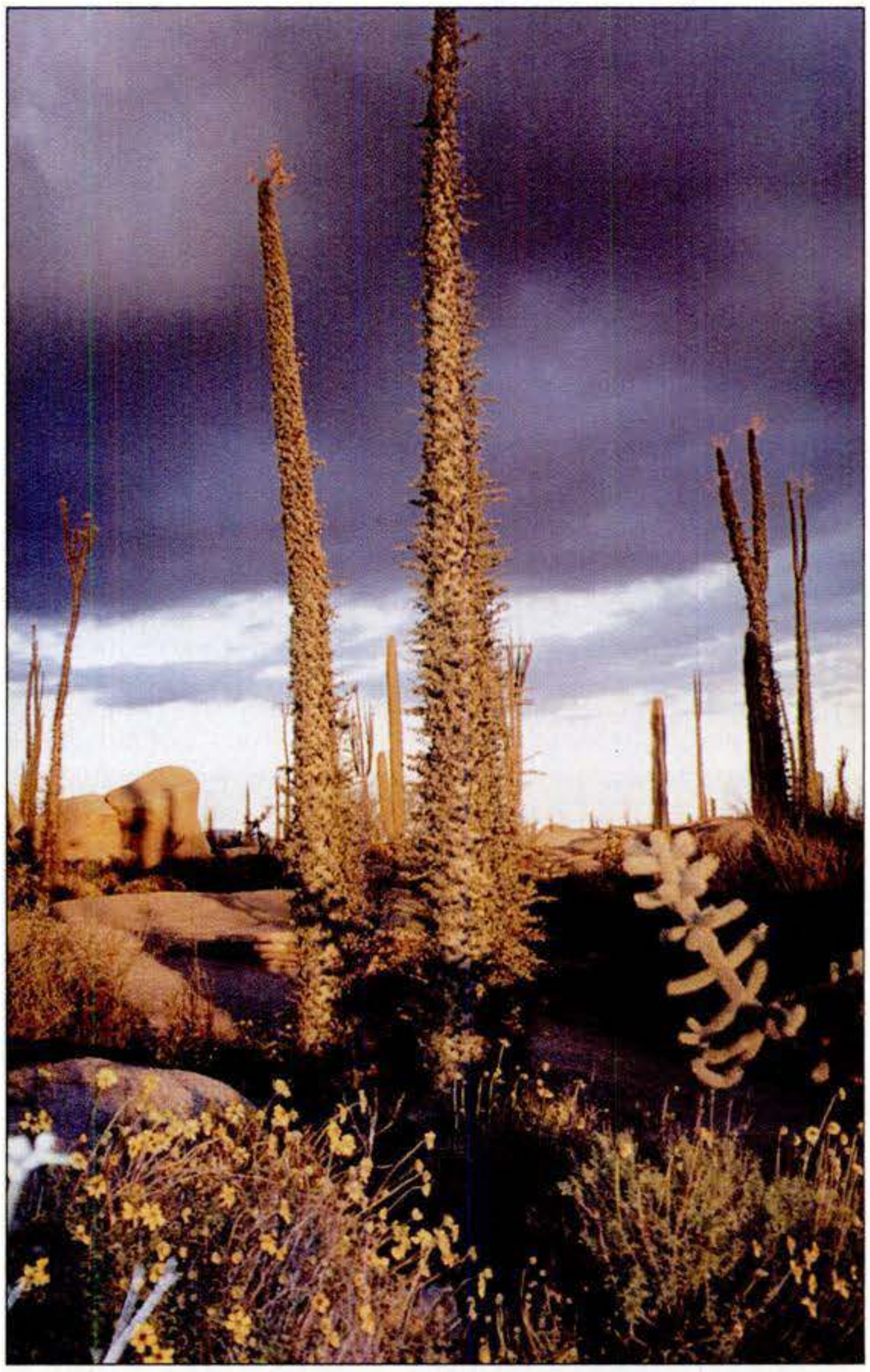
We were "treading lightly," which means respecting the fragile environment by sticking to established trails. If you want to see something off the beaten path, you walk there. Deserts have a long memory; an area in southeastern California still shows the tracks of tank treads made by General Patton's armored troops as they trained for combat in World War II. Slow-growing plant species still haven't fully reestablished themselves. The ability to reach seldom-visited country with a vehicle like the Hummer carries with it a special obligation not to cause any damage.

Baja's economic mainstays are agriculture, tourism, and fishing. The peninsula's population totals about 2.9 million, but most of them live in the northern cities of Ensenada, Tijuana, and Mexicali. Large areas of Baja's interior and southern reaches are thinly settled, with not an electric pole in sight. Several times I drove for more than 20 miles without seeing any inhabitants. The presence of sufficient ground water and rainfall in lonely pockets of mountainous terrain supports small, isolated subsistence ranches whose owners occasionally trek with burros or horses to an outpost to buy and barter supplies. Mostly, Baja is a rugged and empty place.

And it is a place full of rocks. Seasoned Hummer pilots like to demonstrate the vehicle's ability to nose up to and climb a 22-inch vertical obstacle such as a chunky boulder. I experienced a maneuver known as "high-centering," which would be a severely equity-depleting tactic in other off-road vehicles. Once accommodated by the right or left front suspension, a horrible rock will slide beneath the Hummer's steel-armored rocker panel. Then the rear wheel clambers over the geological impediment, and that's that.

Rolling over hills, across plains, through mud, and around patches of quicksand, I spotted many distinctive forms of plant life, including forests of chubby-limbed elephant trees. They look like miniature versions of the baobab tree of West Africa familiar to readers of the children's book *The Little Prince*. There were barrel cacti with waxy yellow-green blooms, fuzzy-looking chollas bristling with aggressive, barbed spines, and sharp-tipped agaves, one type of which furnishes the makings for tequila. In fact, the richest variety of cacti on earth is found here, about 120 species in all, almost three-quarters of them unique to Baja.

At trail's end, I rolled into idyllic La Paz, population 180,000, right on schedule. Although too much terrain had jounced by in too little time, these glimpses of a remote and beautiful world set my resolve to return one day. Driving Hummers down Baja under the conditions they were really built for brought together some of my longtime enthusiasms: exotic machinery, desert wildlife, and following back roads to see where they go. Having fulfilled the boojum quest, I am now back in my 30-mpg Honda Civic, navigating the freeways of Southern California. Evenings, I tend the potted cacti and succulents on my front porch. PS



Technically not a cactus, but rather a spiny shrub, the boojum tree also bears the Spanish name cirio, given for its resemblance to the tall candles that were burned in colonial mission churches. Boojums can sprout new leaves within 72 hours of a rainstorm, later dropping them to conserve moisture until the next splash of scarce water arrives. The tallest ones attain a height of 60 feet and are estimated to be about 360 years old.

Copyrighted material

ADVERTISEMENT

Mind Power Breakthrough!

Plug Your Mind into the Amazing Learning Machine™ To Boost Mental Powers, Program Your Mind for Success & Launch Fantastic Mind Journeys. Plus Get $600 of Free Learning CDs!

Absolutely mind blowing!!! I popped a French Learning CD into the *Learning Machine*™. Immediately I was sucked into a deep, dream-like trance. Weird colors and patterns were created on the insides of my closed eyelids. While in this super-relaxed but hyper-aware state, the special Learning CD began unfolding its magic programming.

A Vacation in 22 Minutes

It was as if a movie were playing inside my head. I could see myself in France having lunch at the Eiffel Tower. The music, the sounds, even the fragrance of summer in Paris. A beautiful woman spoke to me. "Bonjour, mon ami," she said. In an almost unconscious way I began following the dialogue. The mental imagery was so intense I not only understood what was going on, it was like I was there.

Learning at Light Speed

The Learning Machine is more than virtual reality. More than just a cool way to relax after a hard day at work. According to one college professor, "It may be the most powerful learning tool since the invention of the book."

Here's why. When you do a Learning Machine session your mind is cut off from outside distractions. Your attention becomes focused inward as the powerful sensory stimulation (light-sound matrix) bombards your imagination. Ideas and mental images float in and out of your consciousness. It feels like the best dream you've ever had. Then while in this highly euphoric mental space, the Learning CD opens your learning centers to peak receptivity and pours in new knowledge and skills. It's the ultimate mind trip. But it's not just for fun.

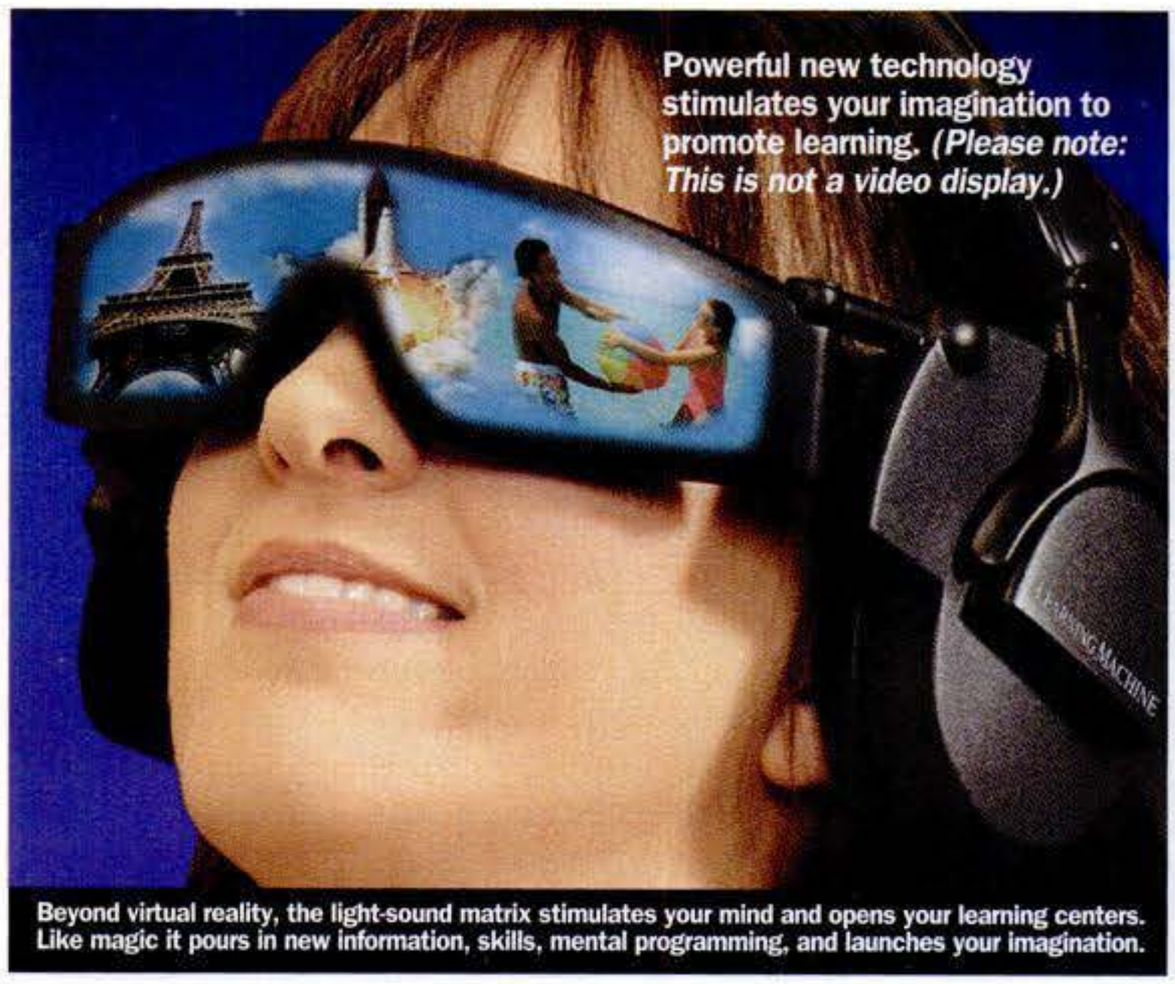
Let's say you want to learn a foreign language, improve your reading and comprehension, or increase your math skills. Or just give your kids a powerful edge in school, learning many times faster than their peers. It's simple.

You select a specially programmed Learning CD in the area you want to study. Plug it into any ordinary CD player. Then attach your Learning Machine digital headset into the headphone jack. Push play and a few moments later your mind is launched into a pre-programmed learning session. In a fun, almost effortless way, the Learning CD unfolds its program and literally forces you to learn. It's the most amazing thing you've ever experienced.

Speak French, Spanish, German & Italian

Learning foreign languages, or anything for that matter, at rocket speed can be very empowering. And I'm going to include a ton of valuable Learning CD software with your Learning Machine so you can get immediate results from this new technology.

You'll receive 4 introductory language courses — French, Spanish, German, and Italian. Plus a Super Vocabulary course, a Super Memory course, and a Super Speed Reading course. And for your kids, a SuperPhonics™ reading program. Over $200 worth of Learning CDs make this the deal of the century. But I also want to show off its other incredible mind expanding powers.



Powerful new technology stimulates your imagination to promote learning. *(Please note: This is not a video display.)*

Beyond virtual reality, the light-sound matrix stimulates your mind and opens your learning centers. Like magic it pours in new information, skills, mental programming, and launches your imagination.

10 Fantastic Mind Journeys

So I'll include the 3-D Mind Sync™ Library, with 10 mind launching programs on 3 CDs. Turn your Learning Machine into a meditation, self-hypnosis, and virtual fantasy computer. You'll get the following titles: *Creativity Booster, Quick Energy, Stress Zapper, Mental Tune-Up, Virtual Visualization, Imagination Stimulator, Learning Accelerator, Super Intuition, Lucid Dreaming,* and *Super Zen States.*

A $150 value, this extensive collection is a super added bonus. But even more exciting is how it can be used for habit control, success conditioning, and eliminating self-sabotaging behavior.

Super Motivation Library

Let's say you want to transform a loser mind-set into a winning one. Or you'd like to quit smoking or lose weight. Pop in an InnerMind™ Programming Disc. The sensory stimulation matrix opens a window into your unconscious mind. Then by infusing your "inner mind" with positive programming, you can rescript negative, self-defeating attitudes. I'm including an awesome 18-title InnerMind Programming Library. From success conditioning to weight control this is another $150 value.

30-Day Risk Free Trial

Plus in addition to the Language Learning Library, the SuperPhonics, Super Speed Reading, Super Memory, and Super Vocabulary programs, the 3-D Mind Sync Library, and the InnerMind Programming Library (a $600 combined value), I'm including coupons worth a thousand dollars. These coupons are for hundreds of future Learning CD applications, including software that links your mind directly to a multi-media computer. It's something you absolutely must experience.

Try the Learning Machine for 30 days risk free. Take your mind on an incredible journey. If for any reason you're not totally blown away by the experience, send your kit back to me for a full refund.

To order, credit card holders call toll free. Or send your check or money order for $299.95 plus $16 shipping & handling to the address below (Item #4501). *Please allow 2-3 weeks for delivery.*

$600 Super CD Bonus Pak

Hundreds of dollars worth of valuable Learning CD Libraries are bundled with your Learning Machine™ to make this an incredible deal. Here is just a sample of the mind-boggling benefits of your Learning CDs that will be bundled FREE as part of this special introductory offer.

***The Teacher*™ (S59 Value)** Start-up demonstration CD will take you on a journey and prep your mind with all the incredible things you can do with your Learning Machine.

***Accelerated Interactive Language Learning*™ *Library* ($200 Value)** 4 introductory courses teach you basic French, German, Spanish, and Italian using the same course materials taught to international diplomats.

***3-D Mind Sync*™ *Library* ($150 Value)** 10 mind journeys: *Creativity Booster, Quick Energy, Stress Zapper, Mental Tune-Up, Virtual Visualization, Imagination Stimulator, Learning Accelerator, Super Intuition, Lucid Dreaming, and Super Zen States.* Launch your mind into fantastic mind journeys from deep meditation to extreme alertness.

***InnerMind*™ *Programming Library* ($150 Value)** 18 programs on 3 Learning CDs program success behaviors into your subconscious. Titles: *Building Self-Esteem, Eliminate Fear & Anxiety, Projecting a Winner's Image, Attracting Love Relationships, Health & Healing, Expanding Psychic Powers, Attracting Prosperity & Wealth, Time Management & Organization,*

Creativity & Problem Solving, Effective Public Speaking, Increase Focus & Concentration, Super Memory & Learning, Stay Fit/Exercise Motivation, Permanent Weight Loss, Eliminate Procrastination, Quit Smoking Now, Meet Your Deadlines, Always on Time.

***Super Speed Learning*™ *Beginner's Pak* ($59 Value)** 4 accelerated learning programs, Super Speed Reading, Super Memory, Super Vocabulary, and SuperPhonics (for kids K-6) teach you learning skills you'll use for life.

Plus $1,000 Worth of Coupons for More Software

Included in your kit are coupons for additional Learning CD programs such as Japanese, The Photographic Mind Series, and Transcendental Mind Series. Plus info on future programs including ESL, Chinese, and Russian. Fantastic Journeys that launch your consciousness into incredible new worlds. The Time Traveler Series. World History. Science & Space. World's Greatest Mind Series. Study Habits Discs. Self-Esteem For Kids. Children's Classic Literature Series. Corporate Training Programs and more. Future multi-media titles include the Civil War series, Everything I Ever Wanted To Know, plus existing CD-ROM software converted into Learning Machine formats.

© 1995 Zygon. All Rights Reserved. Learning Machine, Learning Disc, SuperPhonics, The Teacher, 3-D Mind Sync, Accelerated Interactive Language Learning, InnerMind Programming, Super Speed Learning, Transcendental Mind & Photographic Mind are trademarks of Zygon International.

FOR FASTEST SERVICE CALL TOLL FREE

1-800-925-3263

ZYGON

18368 Redmond Way, Redmond, WA 98052

Fax Orders to (206) 882-1454

Copyrighted material

[Continued from page 76]

programs with the bank's employees.

Universities have been another powerful force in testing smart cards that can handle library book checkouts, cafeteria charges, and other fees. In effect, they constitute both a means of record keeping and an electronic scrip, based on the student's tuition accounts. Ohio has begun a program of issuing welfare payments through smart cards that can be charged at merchants with dedicated equipment, then "decremented," in the industry term. A similar experimental program for food stamps is underway in Dayton, Ohio, and others are planned. The Clinton administration is pushing them as a way to reduce administrative costs. Curiously, the largest smart card program in North America is for peanut farmers. The Department of Agriculture uses smart cards to keep track of their crop sizes and allotments.

At the United States Marines' basic training program at legendary Parris Island, South Carolina, recruits are paid by smart cards that can be used at base facilities or the local bowling alley and Burger King. The Corps figures that the system saves about $40,000 a year, not to mention several hours in the processing of each recruit. In addition, a new generation of dog tags called (in true Pentagon fashion) "Individually Carried Records," or ICRs, contain rank and serial number as well as additional personal information. Indeed, much of the technology used in smart cards for finance is an outgrowth of their use for security purposes.

The gradual arrival of the information superhighway has stimulated new ways to think about card-based cash. Ordering merchandise online now accounts for only a half-billion dollars or so in business. But by some estimates it could rise to $6 billion by the turn of the century. Could, that is, if people are willing to entrust their credit card numbers to the telephone system the same way they learned to entrust them to mail order companies with 800 numbers. This requires not only assurances of security, but convincing the public. When celebrated "most wanted" hacker Kevin Mitnick was arrested, he had a list of 20,000 credit card numbers in his possession. And even though he had not used any of them for purchases, the public took note of the breach, which contributed to a cumulative wariness about security in any links between computers and credit cards.

But card proponents point out that any system has a proportion of fraud. Cash can be counterfeited, checks forged. Cubic's Kane points out that the cost of protection must be traded off against potential losses from theft and fraud. Early this year, a New York transit clerk was caught creating fraudulent Metro Cards. He had figured out a way to load the cards without the computer subtracting an amount from a central depository. But Cubic's software, which looks for untypical events in the operation of the system, noticed something unusual, and the clerk was arrested.

Smart card proponents emphasize that they can limit the risk of lost or stolen cards by limiting the stored value to no more than, say, $50. But, says Gilson, consumers surveyed by the Smart Card Forum remain concerned about fraud. "They are worried about losing the card if it is loaded up with money and about how accessible it is if stolen."

Fraud could be magnified to dangerous proportions on the Internet and other computer information systems. Fear about security remains the sticking point for the next step beyond the smart card: digital money that does not live in a computerized card but in a system of computers. Beyond smart cards are no cards at all—just numbers moving through computers and across phone lines.

The general public's perception of the Internet is one of hackers and break-ins. But already a kind of standard is emerging that its proponents say will soon give customers as much confidence in transmitting credit card numbers over the Internet as they now have in giving them on the telephone.

The de facto emerging standard for coding or encrypting credit card numbers and other purchase information is the RSA model, an encryption scheme devised by three MIT professors. RSA's system uses two numerical keys. One, the so-called public key, is known by recipient and sender alike. The other, private key is known only to the sender. It is the digital equivalent of the two keys required to be turned simultaneously to launch a ballistic missile. LSI Logic is building the RSA encryption algorithms onto chips.

A new World Wide Web system set up by the New York Web for 800 Flowers uses the RSA system along with Netscape's Web server to show buyers images of bouquets they can order after encrypting their credit card numbers.

But even online, smart cards may take the lead. The Smart Card Forum envisions card readers on top of TV sets. These will handle orders for pay-per-view programs, and, potentially, merchandise. But it is also planning an experiment using the World Wide Web on the Internet to test "Smart Card Bucks," an experimental currency for electronic payment tied to a card reader that attaches to a PC. The system will use one of the existing encryption standards.

Smart cards could be a more secure alternative to sending your credit card number over an online service. The Internet, in particular, grew up in such a far-flung and ad hoc manner that some experts fear it can never be made substantially hackproof. Says the head of one software firm that handles online credit, "The Internet is so insecure that what may be needed [to make digital cash work] is a special, dedicated network—a kind of American Express Platinum card of online finance."

Then, there's a form of cybercash that cannot be linked to an owner or spender. One of the first forms of currency online is already international. DigiCash, based in the Netherlands, is the creation of David Chaum, a former computer science professor. With DigiCash, the user is anonymous—unlike with an RSA-type system. Banks and credit card companies are bypassed. DigiCash is untraceable cash and holds potential for money laundering and other fraud. Banks and financial institutions are likely to resist it for many years to come.

Smart cards, on the other hand, begin from a base of familiarity: They are to the credit card what the compact disc was to the long-playing record. Once their acceptance reaches a critical mass, smart cards, like VCRs or microwaves, may become a fact of life far more quickly than anticipated. "There is a higher level of technological sophistication," Gilson notes, among the population, than when magnetic stripe cards were introduced.

The Smart Card Forum has done extensive market surveys, Gilson reports, and found that "Most people have some mind's eye view of what a smart card can do. Fifteen years ago they had no perception at all. They are interested in information access and security features. These are not intimidating."

For the next few years, smart cards are likely to include magnetic stripes and perhaps bar codes along with their chips. These transitional cards will gradually replace the driver's license, medical insurance cards, bank cards, and credit cards that bulge the contemporary wallet.

The shape of the smart card revolution remains murky, but Bob Gilson promises one thing: In ten years, he says, "Twelve cards will be replaced by two or three. Your wallet will be thinner." PS

The professional weather station for people curious about the weather.

Haven't you always wanted a weather station? The Weather Monitor II makes a state-of-the-art weather monitoring system affordable enough for home use!

FEATURES INCLUDE:

- Inside & Outside Temps
- Inside Humidity
- Instant Metric Conversions
- Wind Speed & Direction
- Wind Chill
- Outside Hum. & Dew Point Option
- Barometer
- Alarms
- Time & Date
- Highs & Lows
- Rainfall Option
- Optional PC Interface

Order today:

1-800-678-3669

M-F 7 a.m. to 5:30 p.m. Pacific Time • PS655E
FAX 1-510-670-0589 • M/C and VISA
One-year warranty • 30-day money-back guarantee

DAVIS INSTRUMENTS
3465 Diablo Ave., Hayward, CA 94545

Our #1 rated SoundWorks *amplified speaker system. Factory-direct price: $199.*

FREE STEREO CATALOG

We make speakers and music systems designed by Audio Hall of Fame member Henry Kloss (founder of AR, KLH & Advent). We sell them factory-direct – so you can save hundreds of dollars. *Audio* magazine says we may have "the best value in the world." Our *SoundWorks* amplified subwoofer/satellite speaker system (above) converts a multimedia computer or personal stereo into a terrific sounding music system for only $199. *PC* magazine said, "This is the best $199 you can spend on yourself."

CALL 1-800-FOR-HIFI

CAMBRIDGE SOUNDWORKS®

The Country's Largest Factory-Direct Stereo Company.

311 Needham St., Suite 126 Newton, MA 02164
Canada: 1-800-525-4434 Fax: 617-332-9229

GET RID OF YOUR GUTTERS!
THEY CLOG, LEAK, FREEZE, RUST AND ROT.

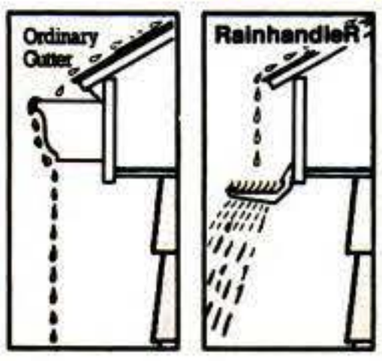
RainhandleRs are installed on homes nationwide. They can be installed on yours in about 3 hours with a screwdriver. **RainhandleR** is virtually invisible, rustproof and comes in white, brown or natural aluminum. For more information send coupon to **RainhandleR** or call 1-800-942-3004

RainhandleR delivers 100% of precious roof rain to your lawn and shrubs. Join us and urge others to protect our water resources for future generations. Some distributor territories available

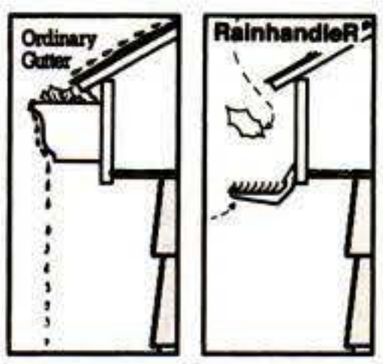
RAINHANDLER™

Dept. PS075 from SAVETIME CORP.
2710 North Avenue, Bridgeport, CT 06604
Please send me your free information kit.
Name _____
Address _____
City _____
State _____ Zip _____
Phone ( ) _____

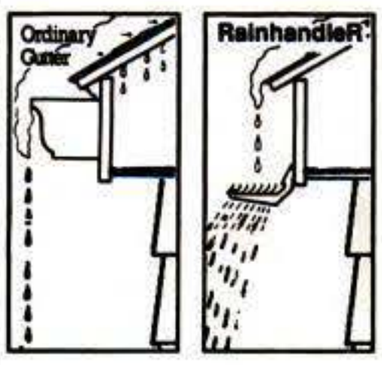
Replace them with the RAINHANDLER



STOP CLOGGING. **RainhandleR** needs no cleaning, because it can't clog. Its patented louvers break up roof water into a spray of tiny drops and disperse them away from your house.



STOP CLEANING. You'll never climb a shaky ladder again to clean a gutter. **RainhandleR** comes clean with a quick blast from your garden hose–from ground level.



STOP WATER DAMAGE. **RainhandleR** in winter, protects your investment by helping to prevent clogs and ice dams on the roof that otherwise lead to water rot and leaks.

Ocean express

[Continued from page 65]

bine engine, a 5.5-meter-long, modified version of the engine used in the McDonnell Douglas MD-11 widebody jetliner. These energy-efficient turbines make Fastship's high-speed service possible. Fastship's freighters will boast eight of these turbines, each pumping out 5,400 to 5,700 horsepower, at 60 percent of the relative fuel consumption of smaller, less powerful turbines.

It's not sheer power alone that makes the high-speed freighters possible, says Fastship CEO Terry Johnson. A radical hull design—also never tried before in a ship so large—will provide unusual stability in bad weather. Dubbed the semi-planing monohull, the hull is much flatter at the stern (in fact, slightly concave) and much wider than a conventional hull of the same length. The flat stern allows the boat to skim across the water as much as it plows through it, while the extra width provides vertical stability normally delivered by a keel. In rough seas, the semi-planing monohull doesn't crash up and down in the waves as much as conventional hulls do. Consequently, unlike other vessels, Fastship's freighters should be able to maintain nearly full speed even in severe storms, according to experts.

The final time-saving technology, according to Fastship's plan, comes when the new ships dock in Philadelphia. With conventional cargo boats, cranes unload boxes through a hatch in the deck. In contrast, the Fastship freighters will feature a stern door that opens up like a car ferry onto a special receiving dock being custom-designed for Fastship by the Delaware River Port Authority. Cargo pallets, stacked two high and linked together into trains, will be pulled out onto the dock at a rate of 1,000 per hour—seven times the speed possible with traditional unloading techniques.

Experts agree that the technology behind the project is sound—but caution that the company's business prospects remain dicey. "The design is very practical for high-speed shipping," says Thomas Lang, a California inventor and hydrodynamicist known for conceiving the dual-hulled SWATH (Small Waterplane Area Twin Hull) boat. "But everything will depend on the economics." The first step for Fastship Atlantic is to raise the $700 million needed to construct an initial fleet of at least two and possibly as many as four ships. If it succeeds, Fastship could deliver its first load of goods to the United States in early 1998. PS

Copyrighted material

The forecast for wind power

[Continued from page 72]

left today is a federal tax credit of 1.5 cents per kilowatt-hour of electricity produced during the first ten years of a turbine's lifetime.

Even without hefty tax credits, a few wind companies have thrived. And in recent years, big companies like Westinghouse and Siemens have shown renewed interest in wind. Utilities are also going with the wind. A few years ago, the American Wind Energy Association had only five utility members; today there are 35.

There is trouble ahead, however. Natural gas prices are now so low that some utilities are scrapping plans to expand wind power and are focusing exclusively on gas-fired generating plants. Wind turbines look simple, but they are expensive. About 80 percent of the cost of wind power goes toward building turbines, with only 20 percent for operation and maintenance. For gas-fired plants, fuel is the primary cost, and it is spread out over many years. Even with wind costs at an all-time low, gas is still slightly cheaper. "We're battling over tenths of a cent," says New World Power's Coleman. "That's the game we're playing."

Some utilities are investigating the idea of "green marketing"—selling electricity produced from renewable sources to environmentally aware customers who are willing to pay a slightly higher price. But even wind power is not an environmental panacea. The plants typically require at least 15 acres of land for each megawatt of capacity, although much of the land can simultaneously be used for activities such as farming or grazing. Some people also find the sound and appearance of wind turbines offensive. And worst of all, turbines at some sites have taken a heavy toll on birds, especially raptors.

Although wind power has made big strides in the last few years, its progress has bogged down in states where there is little political support for renewable energy. The nation's strongest winds are in the Great Plains. "North Dakota has a lot of wind, but not a lot of people live there, and there aren't a lot of transmission lines," says Kenetech's Clarence Grebey. California has strongly supported wind power, but at least 14 other states have better wind resources.

Even in places where the wind blows, it doesn't usually blow at a constant speed throughout the year. But in areas where energy requirements soar during one particular season, wind power can sometimes be matched to peak demand. For example, the wind in Maine's boundary mountains blows strongest during the winter, and that is when down-easters most need electricity to heat their homes.

As wind power moves beyond California, turbine engineers are challenged to design machines that perform reliably in cold weather. For example, Kenetech is experimenting with black blades that would absorb heat to prevent icing. And many companies are building tubular towers that offer maintenance workers more protection from frostbite.

New World Power is even designing a turbine to generate electricity for scientific and communications equipment in Antarctica. NASA is interested in the project, because preliminary calculations indicate that there might be enough wind on the chilly plains of Mars to generate power there. PS

Distributors Wanted

Start Your Own Business with the Leader in Steel Homes

More people are building steel framed homes—over **300%** more every year. Why? It's simple. **To build a better home, you need a better building material**. And as commercial builders have always known, the best building material is steel. Tri-Steel homes are:

- **Stronger**. Build a stronger frame with less pieces. High-strength bolts and screws will not shift or work-out like nails.
- **Safer.** Unmatched protection from fire, earthquakes, high winds, heavy snows, termites and other vermin.
- **Faster**. Pre-engineered system with all components already cut, drilled, marked and ready to simply bolt-together.
- **Energy Efficient.** Big energy savings with 9-inch R-30 insulation.
- **Healthier**. Better indoor air quality with no outgassing from chemically-treated lumber. No need for cancer-causing termicide soil treatments.
- **Consistent**. Predictable quality. Uniform components. Walls are straight, floors are flat, doors do not stick, second floors feel solid. Will not shrink, rot, swell, creep, creak, split, bow, shift, or deteriorate like wood. Stable pricing.
- **Flexible**. Frame is self-supporting, so interior walls can be placed anywhere. Limitless floor plan possibilities with large, open areas, cathedral ceilings, etc.
- **Kinder to the Environment**. Framing the average house could use ten trees — or the recycled American-made steel from only four or five junked cars.

Join the 19-Year International Industry Leader

- Refundable Investment.
- Full Training & Support.
- Construction Assistance
- No Franchise Fees.

To order **FREE** information or $9.95 video:

Call **1-800-TRI-STEEL**

(800)874-7833 (817)497-7070 Fax: (817)497-7497
5400 S. STEMMONS FRWY., DENTON, TX 7 6201

Tri-Steel Structures, Inc.

© 1995, ALL RIGHTS RESERVED

Copyrighted material

DON'T JUNK IT — JB IT!

JB® WELD™

10,000 USES...& COUNTING!

Save time, hassles and money with JB WELD. How? Junking damaged equipment can cost $100's or $1000's — and welding or soldering repairs take time and can cost even more. Instead, use JB WELD cold-weld products and fix many jobs fast — and for pennies!

Join millions of mechanics, body and repair shops and do-it-yourselfers who use JB WELD products every day as adhesives, fillers, patches, insulators and sealants to repair just about anything! And fix them fast — cracked engine blocks, gas tanks, transmission casings, battery boxes, radiator seams, boat hulls, pipes and 1000's of other salvageable items!

JB WELD is America's #1 cold-weld compound. *Cures in hours for steel-hard, permanent repair. Bonds all metals, wood, plastics, fiberglass, concrete, fabric, ceramics. Can be drilled, ground, machined. Also water-proof & chemical-resistant. Withstands 600°F with 3900 lbs. tensile strength! Non-toxic.*

Use These Other Great Products, Too!

JB KWIK cures in just 4 minutes! *Perfect for household, automotive & plumbing repairs, plus hobbies & crafts! Withstands 300°F. Non-toxic.*

CLEAN PREP dissolves dirt & grease in one easy spray. *Maximizes bonding strength. Suitable for most adhesives. Non-toxic.*

WATERWELD makes repairs *underwater.* *Plugs punctured gas tanks & almost anything that leaks! Kneads like putty, then packs into hole. Hardens in just 20 minutes.*

PERM-O-SEAL is the 'original' radiator stop-leak. *Permanent sealant for radiators, water jackets & cylinder heads. Won't redissolve or clog. Contains rust inhibitor & water pump lubricant.*

100% GUARANTEED *or your money back! Available at hardware & discount stores. Send $1.00 for a JB WELD key ring, decal & our new full-line brochure.*

J-B WELD COMPANY

P.O. Box 483, Dept. PS • Sulphur Springs, TX 75483
(800) 529-3530 • (903) 885-7696

© 1995 JB WELD CO.

Crisis in space

[Continued from page 56]

the lander's navigation telescope. But ever since the accident, the sky surrounding Apollo 13 had been filled with sparkling debris that made star sightings impossible.

Guidance expert Ken Russell came up with a solution: The astronauts would sight on the one star that was impossible to miss, the sun. When Lovell heard about the procedure he was skeptical, telling Haise, "I don't have all the confidence in the world in this sun check." But around 3 p.m., when Lovell wrestled the spacecraft into position, Haise sighted through the telescope's protective filter and saw the sun's bright arc. In mission control, flight director Gerry Griffin's hand trembled so badly as he logged this crucial success that he could hardly read his own writing. Around him, the Gold Team of controllers cheered.

Three hours later, Apollo 13 flew into the darkness of the lunar shadow, and minutes after that, out of radio contact with Earth as the spacecraft went behind the moon. For a half-hour the astronauts were truly on their own, like every moon voyager before them. Apollo 13 sped around the moon like a toboggan taking a curve until it was, at last, heading toward Earth.

At 8:40 p.m., Lovell and Haise stood side by side at *Aquarius*' controls, ready for the PC+2 burn. At the proper moment, Lovell pushed a button to light the descent rocket. For four minutes, the engine fired silently in the void, working so perfectly that Lovell wished he were using it to land on the moon. Instead, he and Haise now did the unthinkable, turning off nearly all of *Aquarius*' systems to save power, including the computer and guidance system. Without them, Lovell wondered how he would be able to make any more maneuvers. But this, again, was a question mission control would have to answer.

Wednesday, April 15, was tax day. For the weary flight controllers on Gene Kranz's White Team, sleep had been curtailed not only by anxiety but by the burden of filling out returns. Arriving back at the control center Wednesday morning, they were a tired group, but there was no time for rest. With the PC+2 burn successfully out of the way, Kranz's teams could finally concentrate on the crucial reentry checklist.

Meanwhile, the astronauts—who were by now quite weary themselves—were dealing with another, even more immediate worry. Fred Haise had forgotten, when he assessed *Aquarius*' supplies, that Jack Swigert's presence in the lander meant that carbon dioxide would build up more rapidly than normal. The lander's environmental control system used round canisters of lithium hydroxide to remove CO_2 from the cabin atmosphere, but by Wednesday morning the supply was almost used up. If nothing were done, the astronauts would suffocate from their own exhalations.

Once again, mission control came up with a solution. The canisters in *Odyssey* were square and wouldn't fit into *Aquarius*' environmental control system. But the astronauts could adapt one of them using items available onboard—a plastic storage bag, a plastic cover from a flight plan book, and gray tape. The makeshift oddity ended up looking something like a mailbox. And it worked: Minutes after Haise installed it on one of the lander's oxygen hoses, the carbon dioxide level fell toward normal.

The "mailbox" epitomized the ingenuity that mission control was bringing to bear on each problem as it arose. But there was one problem none of the experts on Earth could remedy: It had become very cold inside Apollo 13. That was an inevitable result of the power-saving measures; without the normal heat output from the spacecraft's electronic equipment, the cabin had cooled rapidly. Now, on Thursday morning, the temperature in *Odyssey* had fallen to 38°F, making sleep impossible. The astronauts, who had been calling it "the upstairs bedroom," now named it "the refrigerator." Water droplets had condensed all over the walls and instrument panels. And *Aquarius* wasn't much warmer. The astronauts' thin coveralls provided little insulation; even an extra pair of long johns made little difference. And Swigert's feet, which had gotten wet from a leak in the drinking water dispenser, were half-frozen.

The afternoon dragged on with the three men shoulder to shoulder in the lander's tiny cabin, trying to stay warm. The cold made the wait for the long-anticipated command module activation checklist seem even longer. Reentry was less than a day away, but the procedures still weren't ready. Lovell's crew could only picture the army of controllers hard at work on the problem. One of them was a healthy Ken Mattingly, who never got German measles after all. But when Thursday evening arrived with no checklist, Lovell—who had shown remarkable calm since the accident—lost his composure. "We just can't wait around up here," he told Capcom Vance Brand, adding that he and his crew would need enough time to study the proce-

Copyrighted material

Crisis in space

[Continued from page 86]

dures very thoroughly, and then, "we've got to get the people to sleep."

Finally, around 7:30 p.m., Mattingly came to mission control to read the newly crafted checklist to the man who had taken his place aboard Apollo 13. The session lasted almost two hours, and when it was over, Mattingly reassured Swigert that the procedures had been thoroughly tested in the simulators. "I hope so," Swigert said, "because tomorrow is examination time."

In the small hours of Friday, April 17, Lovell and his crew, verging on exhaustion, could see the crescent Earth looming before them, growing bigger by the minute. But that Earth was still not within reach; Apollo 13 had strayed off the proper path for reentry. Lovell knew only too well how precise that path had to be: too steep and the command module would burn up in the atmosphere; too shallow and it would skip off the atmosphere like a stone skimming the surface of a pond. Some unknown force (which turned out to be normal venting from *Aquarius'* cooling system) was causing Apollo 13's trajectory to be shallow. And so, with reentry only hours away, Lovell steered his craft into position for a final corrective maneuver.

Meanwhile, in mission control, NASA doctors worried about the men's condition. Worn down from cold and lack of sleep, they faced one of the most critical and unforgiving times of the mission. An error now could be deadly. (What the doctors did not know was that Haise had come down with a urinary tract infection while wearing a urine collection bag, and was truly exhausted.) Deke Slayton, the astronauts' boss, came on the radio to suggest that Lovell and his crew take Dexedrine to stay alert. Lovell worried to himself that the drug's letdown might leave them more tired than they already were. And soon, there wasn't any need for Dexedrine: Capcom Jack Lousma informed Lovell that it was time to start powering up the lander, which had come through the ordeal with power and cooling water to spare.

At 7:15 a.m., it was time to cast off the stricken service module. When Swigert punched the button, the cylindrical module drifted away, and for the first time all three men could see what had happened to Apollo 13. Instead of a small hole, an entire panel had been blown off, revealing the guts of the module. Lovell exclaimed, "There's one whole side of that spacecraft missing!" The words had a chilling effect on those listening in mission control, where some worried whether the blast had cracked the command module's heat shield. If so, there was no possible way of fixing it.

Aboard *Odyssey*, Jack Swigert and Fred Haise had more immediate concerns as they prepared to turn on the command module's systems. Now was the moment of truth. Miraculously, *Odyssey* came back to life in perfect condition.

Only one more task remained prior to reentry. When Lovell had joined the others safely inside the command module, the men sealed off the hatchway, and then, with a mixture of sadness and gratitude, cast off the spacecraft that had saved their lives. From Houston, Joe Kerwin radioed an appreciation: "Farewell, *Aquarius,* and we thank you."

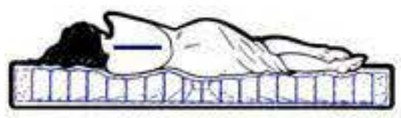
As the time for *Odyssey*'s reentry neared, mission control was jammed with controllers and off-duty personnel. "Everybody says you're looking great," radioed Joe Kerwin. "Welcome home."

"Thank you," came the response, and then there was silence. Apollo 13

Relieve Back Pain!

Frustrated With Your Sleep?

Do you toss and turn at night? Can't seem to find a comfortable position? Does your back ache when you awake? These are signs that your mattress doesn't support you properly.

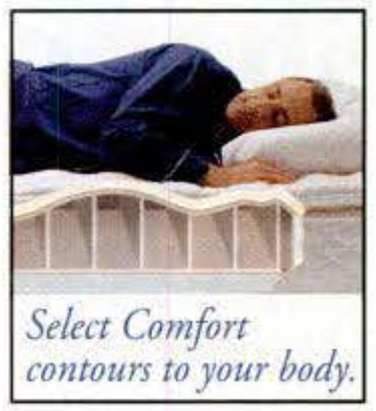


Select Comfort's patented air cushion design has no springs or coils that can create pressure points and uneven support.

Metal coil mattresses support only the firm parts of your body, creating pressure points, and uneven spinal support.

With Select Comfort, you each get exactly the firmness you need.

Also it keeps your spine in its ***natural alignment.*** And that lowers the tension in the surrounding muscles. So you can sleep comfortably in any position and wake feeling great.



Select Comfort contours to your body.

Call For More Information

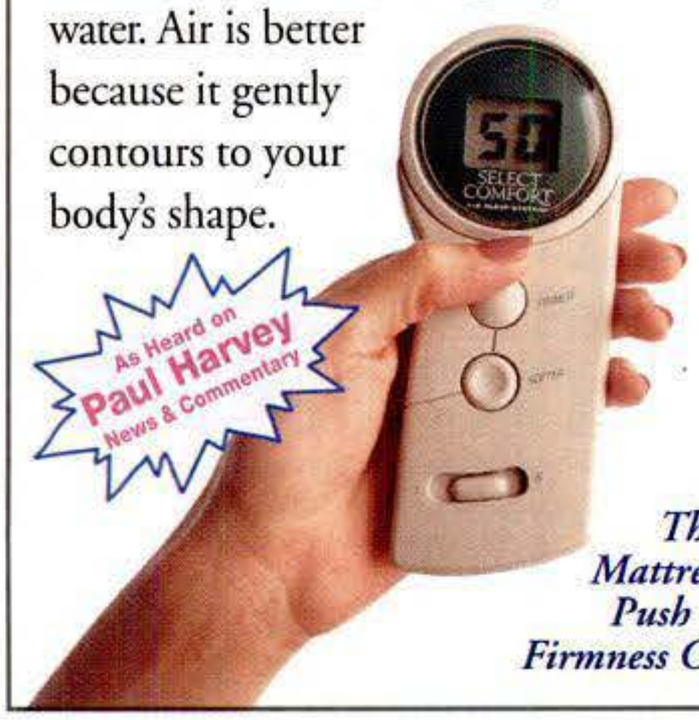
You owe it to yourself to learn more about this revolutionary way to a better night's sleep.

For FREE Video and Brochure, Call

1-800-831-1211

Sleep Better On Air

A Select Comfort adjustable firmness mattress doesn't rely on springs or water. Air is better because it gently contours to your body's shape.



The Only Mattress with Push Button Firmness Control.

Yes! Please rush me a FREE Video and Brochure.

Name_____

Address_____

City_____ State _____

Zip_____ Phone_____

SELECT COMFORT™

Mail to: Select Comfort Corporation
6105 Trenton Lane N., Minneapolis, MN 55442

© Select Comfort Corp., 1995 Dept. 4232

Copyrighted material

Crisis in space

[Continued from page 87]

was slamming into the atmosphere, creating an ionized trail that blacked out communications for what seemed an eternity. A full minute after the blackout's scheduled end, there was no signal. Finally, they heard Jack Swigert's voice: "OK, Joe." Still no one could breathe easy; they wondered, were the electronics used to deploy the parachutes still good? The big screen at the front of mission control—and televisions around the world—showed a clear, calm morning in the South Pacific. Minutes went by as controllers counted down to the time of parachute deployment. Finally, after long minutes, the camera found the cone-shaped craft descending under three beautiful, perfect parachutes. By the time the astronauts came gently to rest in the Pacific, cheers and applause had erupted in mission control, throughout NASA, and at Apollo contractors across the country. The triumph belonged to these Earthbound heroes as much as to the astronauts; years later, many would call Apollo 13 NASA's finest hour.

What had gone wrong aboard Apollo 13? The review board found an unlikely chain of events dating back to 1965, when Apollo's designers upgraded the operating voltage of the entire spacecraft from 28 to 65 volts. One subcontractor, who manufactured thermostats for the oxygen tanks' internal heaters, never got word of the change. The flawed thermostats never caused any problems because the heaters were never used—until a ground test sometime before Apollo 13, when the spacecraft's tanks were filled with cryogenic fluids and then drained. Oxygen tank number 2 wouldn't drain properly. Engineers studied the problem and learned that the tank—originally slated for a previous Apollo flight but later removed and replaced—had suffered a minor jolt during handling, which had slightly damaged the tube used to fill and drain the tank.

To work around this difficulty, the engineers decided to turn on the tank's heaters to boil off the liquid oxygen, a process that took eight hours. But the tank's flawed thermostat, which was supposed to control the internal temperature, wasn't working: It had welded shut as soon as voltage was applied. Temperatures inside the tank reached 1,000°, but no one knew—because the temperature gauge used to monitor the procedure didn't go past 85°. Inside the tank the intense heat cracked insulation on some wires leading to a nearby motor, the one that controlled the tank's fan.

Nothing more happened until the night of April 13, 1970, when mission control asked Jack Swigert to turn on the fans inside the oxygen tanks. At that moment, the review board determined, there was an electrical arc inside tank 2. Within moments it became a fire, fed by the oxygen supply. The resulting pressure blew off the tank's dome, flooding the compartment inside the service module with oxygen. When the pressure in the compartment reached 30 pounds per square inch, it blew off the outer panel with a jolt that probably also severed the plumbing to tank 1, crippling Apollo 13.

Less than eight months later, in January 1971, Apollo 14 lifted off with three redesigned oxygen tanks and other improvements, to complete the mission that Lovell's crew had been denied and begin the scientific exploration of the moon in earnest. PS

Shoppers' Showcase

A selection of products and services for POPULAR SCIENCE readers are available directly by mail. Enjoy the fun and convenience of mail order shopping. Please order directly from the advertiser. For advertising rates for this section, write or call Diane Pahl, Direct Response Manager, POPULAR SCIENCE, 1000 Town Center, Suite 1830, Southfield, MI 48075; (810) 350-3800; fax # (810) 350-3557.

SHOP - TASK
MILL · LATHE · DRILL
The Original Home Machine Shop Designed in USA by Shoptask

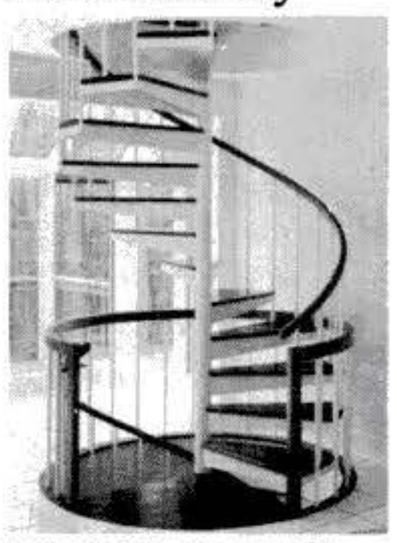
3 Versions to Choose
CNC Capability
3 Axis Power Feed Available
12 Month Warranty
100% Parts Supply
All Tooling Available
17" Swing
11 x 18 Mill Table

1-800-343-5775 FREE BROCHURE
DEMAND THE BEST
SHOPTASK P. O. Box 186, Aberdeen, WA 98520
SINCE 1981

What Is He Doing?

He's making a concrete flower pot... and so can YOU!
Make and sell your own ornamental concrete items. Order your book about 425 aluminum molds, prices and production trade secrets from the world's largest mold manufacturer. Book only $10
CONCRETE MACHINERY CO., INC.
P.O. Box S99, Hickory, NC 28603

SPIRAL STAIRS
Coast to Coast Delivery



FREE ENCLOSED TREAD ENDS $220.00 VALUE
Save 30 % to 50%
Stock & Custom Stairs
Strong Steel Frame
Oak or Brass options
3'6" to 7' Diameter
Easy To Install
FREE BROCHURE
Call or Write -
SALTER INDUSTRIES
P.O. BOX 183, EAGLEVILLE, PA 19408
610-631-1360 FAX 610-631-9384 PS795

CABLE TV DESCRAMBLERS
• Quantity Discounts • 24 Hour Shipping
• Save Money Don't Rent
NOBODY BEATS OUR PRICE
Call Us Last For Best Price
1-800-677-0321
Anyone implying theft of service will be denied service
VCI - NO FLORIDA SALES

Build your own
DOME
Pre-cut dome home kits in a variety of floor plans up to 3,000 sq. ft. Complete kits start as low as $6,795. Attractive, easy-to-assemble, energy-efficient. S12 for new 100-page catalog package. Color video S10 more.
TIMBERLINE GEODESICS
2015 Blake St., Berkeley, CA 94704 1-800-DOME-HOME

SINGERS! REMOVE VOCALS
Unlimited, Low Cost, Instantly Available Background Music from *Original Standard* Recordings! Does Everything Karaoke does... *Better and* gives you the Thompson Vocal Eliminator™
Free Brochure & Demo Tape
LT Sound Dept PS -1
7988 LT Parkway
Lithonia, GA 30058
24 Hour Demo/Info Request Line (404)482-2485 Ext 60
When You Want Something Better Than Karaoke!

CABLE TV DESCRAMBLERS

Best Prices in the U.S.A.! We Will Beat Any Price!

Jerrold, Scientific Atlanta, Panasonic
Pioneer Green, FTB3, SA3, Super-Pio

Jerrold Impulse & Starcom series (Stealth)
Sci. Atlanta inc. 8536/+, 8580, Drop-field (M80)

FAST SHIPMENTS FREE CATALOG
30 DAY MONEY BACK GUARANTEE

1-800-818-9688 M-F: 9-6 EST

U.S. Cable TV, Inc. Dept.: KPS075
4100 N. Powerline Rd. Bldg. F-4 Pompano Beach FL 33073

Earn $4,000 Per Month From Your Home With A Computer!

Begin part-time and still retain the security of your present position. We offer 20 services you can perform for your community from your home. No experience necessary—easy to learn. We provide training and computer. For FREE explanation cassette and literature call:

1-800-343-8014, ext. 109

Computer Business Services, Inc.

53 Ways to Help You Qualify for the Job You Want

Free Facts about Career Diplomas and Degrees

Now, at home in your spare time, without any previous experience, you can train for a money-making career...even get a Specialized Associate Degree. Call or send for free information on the career field that interests you most and how to train for it.

CALL TOLL FREE **1-800-595-5505 Ext. 7723**
CALL ANYTIME—24 hours a day, 7 days a week.
OR MAIL COUPON TODAY!

266ZQ

ICS SINCE 1890 **International Correspondence Schools**
Dept. APCS65S, 925 Oak Street, Scranton, **PA 18515**

Send free facts on how I can study at home for **the** career **I have** chosen. No obligation. No salesman will visit. **Check One Box Only!**

ASSOCIATE IN SPECIALIZED BUSINESS DEGREE PROGRAMS
- ☐ Business Management
- ☐ Accounting
- ☐ Bus. Mgmt.—Finance Option
- ☐ Bus. Mgmt.—Marketing Option
- ☐ Applied Computer Science
- ☐ Hospitality Management

ASSOCIATE IN SPECIALIZED TECHNOLOGY DEGREE PROGRAMS
- ☐ Civil Engineering Technology
- ☐ Mechanical Engineering Technology
- ☐ Electrical Engineering Technology
- ☐ Electronics Technology
- ☐ Industrial Engineering Technology

CAREER DIPLOMA COURSES
- ☐ High School
- ☐ Auto Mechanics
- ☐ Surveying & Mapping
- ☐ Drafting
- ☐ Air Conditioning & Refrigeration
- ☐ Wildlife/Forestry Conservation
- ☐ Police Sciences
- ☐ Diesel Mechanics
- ☐ Electrician
- ☐ Small Business Management
- ☐ Gun Repair
- ☐ Electronics
- ☐ Bookkeeping
- ☐ Child Day Care
- ☐ Medical Office Assistant
- ☐ Dental Office Assistant
- ☐ Legal Assistant
- ☐ Legal Secretary
- ☐ Art
- ☐ Motorcycle Repair
- ☐ Hotel/Restaurant Management
- ☐ Catering/Gourmet Cooking
- ☐ Computer Programming
- ☐ Personal Computer Specialist
- ☐ PC Repair
- ☐ Desktop Publishing & Design
- ☐ Secretary with Computer
- ☐ Computer-Assisted Bookkeeping
- ☐ Fitness & Nutrition
- ☐ Fashion Merchandising
- ☐ TV/VCR Repair
- ☐ Photography
- ☐ Animal Care Specialist
- ☐ Journalism/Short Story Writing
- ☐ Interior Decorating
- ☐ Florist
- ☐ Teacher Aide
- ☐ Home Inspector
- ☐ Real Estate Appraiser
- ☐ Professional Locksmithing
- ☐ Appliance Repair
- ☐ Medical Transcriptionist

Name_____ Age_____
Address_____ Apt. #_____
City/State_____ Zip_____
Phone ( )_____

Wet basement? Here's the solution

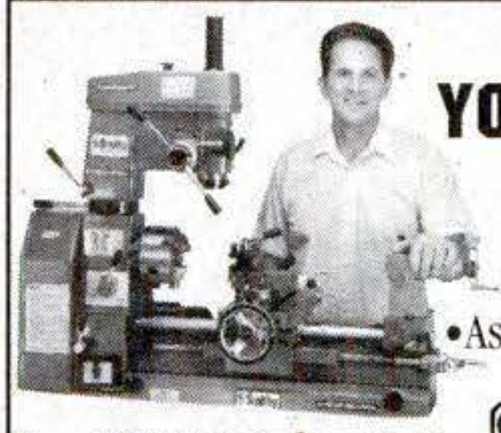
Simple to Understand – Step by Step VIDEO
Solves Leaking Basement Problems

Viordi Corp.
Flushing, NY
1-800-430-0118

$29.95 + $4.00 Shipping & Handling

OWN A MACHINE SHOP

Do your own machining and shop work with a Smithy 3-in-1 Lathe • Mill • Drill



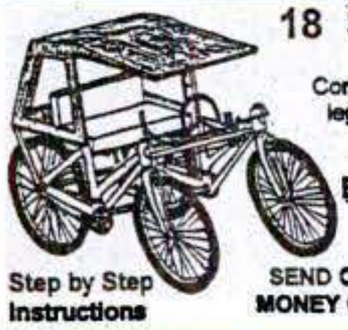
FIX IT YOURSELF!

- Easy to use!
- Save Money!
- Save Time!
- As low as $1095

For *FREE* Catalog Call:
1-800-4SMITHY
1-800-476-4849
(Ask for operator PS)

Smithy
or write:
Smithy Dept. PS
3023 E. 2nd Street
The Dalles, OR 97058

18 SPEED CARBIKE



Cruise in style with the 18 SPEED Convertable CARBIKE. Built with street legal parts. 1 SEATER PLANS $11.95
2 SEATER $12.95 or order both for $15.95

EASY TO BUILD

Step by Step Instructions

SEND CHECK OR MONEY ORDER TO: CARBIKE Company P.O. BOX 149 SPARTA, TN 38583

FROM FRONT... TO REAR...

EXPLORER MAT SHOWN

MATS IN RICH MATTE BLACK WITH A RED PINSTRIPE

HERE'S PROOF. Only ***WeatherTech***® mats give you all-season protection like this: up to 13 lbs. of pliable virgin rubber that's channeled so deep it can trap and hold up to 1 1/2 quarts of water, slush or sand! It doesn't curl, crack or harden, even in sub-zero temperatures. ***WeatherTech***® mats are attractive, with a high-tech design manufactured to fit what you drive. **MORE PROOF.** You may not know it, but Cannon™ of England, the manufacturer of ***WeatherTech***®, is an original equipment supplier to Ford, GM, Honda, Toyota, Lexus, Mercedes, Nissan, Audi and others.

PRICED TO BE THE WORLD'S BEST MAT VALUE: Typical car mats can cost a small fortune at a car dealer, but ***WeatherTech***® mats are anything but typical!

Deep grooves trap and hold snow, mud or sand

Anti-skid ridges prevent slipping

FRONT SET: per set **$44.95** plus $7 shipping*

FRONT AND REAR SET: **$79.95** complete. Free shipping*

WeatherTech® liners take a back seat to no one when it comes to cargo area protection. Our tough, durable liners are molded to your specific vehicle . . . exactly! The ***WeatherTech***® liner is engineered to grip your cargo and minimize load shift plus a 3 inch high lip to contain spills. So now for the first time, ***WeatherTech***® protection can be yours from front to rear!

GRAND CHEROKEE LINER SHOWN

FROM $69.95 plus $8 shipping*

ANY COMBINATION, AND WE SHIP FREE!

SPORT UTILITY LINER APPLICATIONS:
Blazer • Bravada • Bronco • Cherokee • Grand Cherokee
Explorer-Navajo • Jimmy • Land Cruiser • Montero • Rodeo/Passport
Range Rover-Discovery, County, 4.0 SE • Pathfinder
Suburban • Tahoe • Trooper • Wrangler • Yukon • 4Runner

MINIVAN LINER APPLICATIONS:
Aerostar (Ext.) • Astro/Safari (Ext.) • Gr. Caravan
Gr. Voyager • MPV • Odyssey • Previa • T & C • Villager/Quest • Windstar

AUTOMOBLIE TRUNK LINER APPLICATIONS:
Accord • BMW 3, 5 Series • Camry • Concorde
Intrepid • Lexus ES300, LS400 • Maxima
Mercedes "C", "E", "S" Class • Taurus/Sable • Vision

MATS TO FIT MOST DOMESTIC AND IMPORTED CARS, TRUCKS, VANS, AND SPORT UTILITY VEHICLES:

Acura • Alfa Romeo • Audi • BMW • Buick • Cadillac Chevrolet
Chrysler • Daihatsu • Dodge • Eagle • Fiat Ford • GEO • GMC
Honda • Hyundai • Infiniti • Isuzu • Jaguar • Jeep • Lexus
Lincoln Mazda • Mercedes • Mercury • Mitsubishi • Nissan
Oldsmobile Peugeot • Plymouth • Pontiac • Porsche
Range Rover • Renault • Rolls Royce • Saab • Saturn
Sterling • Subaru • Suzuki • Toyota • VW • Volvo

WE GUARANTEE YOUR SATISFACTION.
If you are not happy with your order, return your unused mats or cargo liner within 30 days for a complete refund, less shipping.

*We pay shipping within the 48 contiguous states on orders of a front & back set, two or more sets, or a combination of mats and cargo liner. Extra shipping charge may apply outside the 48 states. If paying by check send checks payable to MacNeil Automotive Products Ltd. IL residents add 6 3/4% sales tax.

We've Got You Covered

Order Today: 1(800) 441-6287
Call 8 AM -10PM (Central Time) 7 days
Major credit cards accepted.
We usually ship within 48 hours. Simply tell us the make, year and model, and we'll send you the ***WeatherTech***® mat or liner engineered to fit.
Express shipping available.

MacNeil®
Automotive Products Limited
2435 WISCONSIN AVENUE
DOWNERS GROVE, IL 60515
708-769-1500 fax 708-769-0300

WeatherTech is a registered trademark of MacNeil Automotive Products Limited

Copyrighted material

FREE INFO!

You Can Drill Your Own Water Well!

Tap the Lifetime Supply of FREE Water in your own Backyard!

This man is drilling a well in his own backyard for less than one third the cost of hiring a commercial well driller. Since 1962, thousands of happy gardeners and homeowners around the world have discovered the **Hydra-Drill™** secret. They drilled their own wells and their gardens prove it! You can, too. Call or write us today and we'll send you a big, free package of information about drilling your own well with the **Hydra-Drill™**.

Ask about our "How To..." video!

Call Today for FREE Water Well Drilling Information Package

1-800-333-7762

(Ask for Operator 7729)

DeepRock 7729 Anderson Road Opelika, AL 36802

❑ ***YES!*** Send the **FREE INFORMATION PACKAGE.** and the illustrated guide ***HOW TO DRILL YOUR OWN WATER WELL.***

Print Name

Address

City/State/Zip

Phone (must have)

© 1995 DeepRock

Celebrate July 4th & All Events

CARBIDE CANNON

BIG BANG! $119.95

Mammoth Cannons shoot with terrific BANG! Have a bang-up time at special events. Uses powdered carbide ammo. Hundreds of shots for few cents. All metal construction with large, rugged cast-iron wheels. Machined brass mechanism for easy loading and firing. Authentic turn-of-century design. Handsome decor when not in use. Made in USA to last a lifetime. Available in 3 sizes: 9" cannon, **$49.95 postpaid;** 17" cannon, **$89.95 postpaid;** 25" cannon (shown here) with rapid firing and automatic loading, **$119.95 postpaid.** The larger the cannon the louder the bang! **Carbide ammo, about 100 shots, $6.00; 3 packs for $15.00.** Send check, money order or call. Visa, MasterCard accepted by mail or phone. Give card number & expiration. Money-back guarantee. Send for **FREE CATALOG!**

The Conestoga Co., Inc., Dept PS, PO Box 405, Bethlehem, PA 18016

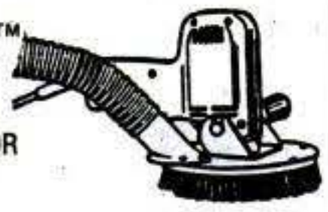
★★ **Call 1-800-987-BANG (2264)** ★★

PAINT REMOVAL and SANDING TOOLS

PAINTSHAVER™

- POWER TOOLS FOR ECOLOGICALLY SAFE REMOVAL OF PAINT
- STRIPS 1 SQ. FT. IN 15 SEC.

S344 SANDER VAC™



- FOR DUST-FREE SANDING OF MOST SURFACES. INDOOR and OUTDOOR USE.

AMERICAN INTERNATIONAL TOOL IND., INC.

1-800-932-5872 **(401) 942-7855**

The amazing walk-behind brush cutter!

The DR® FIELD and BRUSH MOWER

CLEARS & MAINTAINS meadows, pastures, woodlots, wooded and rough non-lawn areas with ease. **CUTS** tall grass, weeds, brambles, tough brush and saplings up to 1" thick.

CHOPS/MULCHES most everything it cuts. Leaves NO TANGLE of brush to pick up like hand-held brushcutters and sicklebar mowers. Perfect for low-maintenance wildflower meadows, European-style woodlots, walking paths, or any area you only want to mow once a month or once a season!

- *Self-Propelled*
- *Mows up to 1/2 acre per hour!*
- *8 HP*

TOLL FREE 1(800) 293-7100

Please mail this coupon TODAY for complete FREE **DETAILS** of the **DR® FIELD and BRUSH** MOWER including prices, specifications, and "Off-Season" Savings now in effect. There is no obligation.

Name_____PSC

Address _____

City _____State _____ ZIP _____

To: **COUNTRY HOME PRODUCTS®**, Dept. 602
Ferry Road, Box 89, Charlotte, VT 05445

©1995 CHP, Inc.

Save on Cable rental fees!

CABLE TV DESCRAMBLERS

WE'LL BEAT ANY PRICE

JERROLD–TOCOM–ZENITH–HAMLIN
OAK–PIONEER–SCIENTIFIC ATLANTA

- *24 HOUR SHIPMENTS!*
- *30 DAY MONEY BACK GUARANTEE!*
- *QUANTITY DISCOUNTS!*

MASTER CARD • AMEX • VISA • C.O.D.

1-800-284-8432

Have make and model number of equipment used in your area ready.
All Shipping & Handling Fees at Customer's Expense.

CABLE WAREHOUSE

10117 West Oakland Park Blvd., Suite 315, Sunrise, FL 33351
(NO FLORIDA SALES)
Anyone implying theft of service will be denied assistance.

CANSBOTTLESPAPERPLASTIC

You just separated your trash.

Recycling is easy, isn't it? In fact, it's one of the easiest ways you personally can make the world a better place.

If you'd like to know more, send a postcard to the Environmental Defense Fund-Recycling, 257 Park Ave. South, NY, NY, 10010.

You will find taking the first step toward recycling can be as easy in practice as it is here on paper.

RECYCLE
It's the everyday way to save the world.

ENVIRONMENTAL DEFENSE FUND

FOR SPEEDIER DELIVERY PLEASE USE YOUR ZIP CODE

Copyrighted material

NU-TEK ELECTRONICS

Leading the way to excellence

NECA BBB

DECLARE YOUR INDEPENDENCE FROM THE CABLE COMPANY

***Own* your own cable TV equipment**

STARGATE 2001 CONVERTER/DESCRAMBLER COMBINATION SPECIAL

- Freestanding Digital Descrambler
- 83 Channel Capacity
- Sleep Timer
- Remote Controlled Favorite Channel, Last Channel Recall
- 2 Gold Tipped Coaxial Cables
- Coaxial Surge Protector

4TH OF JULY SALE ONLY
$177.6

1-800-228-7404

UPS FEDERAL EXPRESS

FREE CATALOG

OFFER EXPIRES ON JULY 31, 1995

AMERICAN EXPRESS MasterCard VISA DISCOVER

3250 Hatch Rd. Cedar Park, TX 78613

NOW! A Galaxy of Savings

Get rid of endless monthly equipment rental fees!

Owning your cable equipment saves you the high-cost of monthly rental charges, and gives you complete control of your TV.

CONVERTERS & DESCRAMBLERS!

Everquest • Panasonic • Jerrold • Zenith • Pioneer
Scientific Atlanta • Oak • Eagle • Hamlin • Tocom

1-800-624-1150

FREE CATALOG!

DISCOVER VISA MasterCard

NCCA Member of National Consumer Cable Association

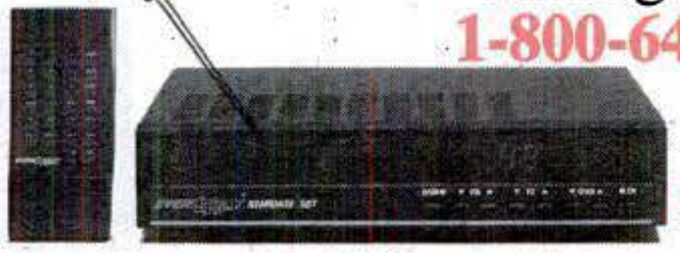
MD Electronics

875 S. 72nd Street • Omaha, NE 68114

SHOW TIME CABLE

Your Cable Connection To The Stars!

Order your **FREE** catalog today!
1-800-643-4258



STARGATE SST

- Converters & Descramblers
- All Makes & Models
- Quantity Discounts
- 30-day Money Back Guarantee
- Best Warranties

Show Time Cable • 643 N 98th St STE 260 • Omaha, NE 68114

COD • MasterCard • Visa • Amex • Discover

INTRODUCING STARGATE SST BASE BAND CABLE CONVERTER BOX

Replaces JERROLD & SCIENTIFIC ATLANTA Products

Features:

- Built-in Descrambler
- Infrared Wireless Remote Control
- Non-Volatile Memory
- Programmable Parental Lockout
- Switched Electrical Outlet
- Audio-Video Ports
- Sleep Timer
- Auto Fine Tuning
- Volume Control

$319

MD Electronics

875 S. 72 Steet • Omaha, NE 68114

CALL NOW 1-800-624-1150 FOR YOUR FREE CATALOG!

Copyrighted material

Popular Science Classified Opportunity Mart

CABLE TV CHANNELS

EQUIPMENT Direct!

FREE 30 DAY TRIAL
GUARANTEED
SAVE $1000's
The Nationwide source for cable TV equipment.
"BUY WHERE THE DEALERS BUY."
FREE
TV Cable Descramblers, Converterters and Magic Box Catalog. Open Every Day!
YOUR VCR TAPES CAN PLAY AS CLEAR AS DAY!
UNJAM NOW WITH Video Decoder
2 Year Warranty
Eliminates copy protection on any tape.
VISA • MC COD

- Copy any rental/bought tape
- Power Cord and RC Plugs Included

Member Better Business Bureau

CALL NOW! FREE 30 Day Trial!

MEGA ELECTRONICS

1-800-676-6342

SOLAR ELECTRICITY

POWERGLASS™ RS
$79.95 + $5 S&H

Energize these Radio Shack™ portable AM/FM cassette players and TVs with the power of sun:

AM/FM Cassettes	AC/DC TVs
14-706, 14-725	16-121, 16-122
14-731, 14-745	16-124, 16-126
14-749, 14-861	16-127, 16-128

Stop buying and tossing expensive batteries. Start using Solar PV Electric Panels from SECO and stop polluting the environment with toxic waste.

Credit card orders call 1-800-700-1867

Or send check or money order to: SECO P.O. Box 4445 Chatsworth, CA 91313

CABLE TV CONVERTERS

Save $100's
- All makes and models
- Years of customers complete satisfaction
- Quality Equipment
- Shipped within 24 hrs
- Free catalog

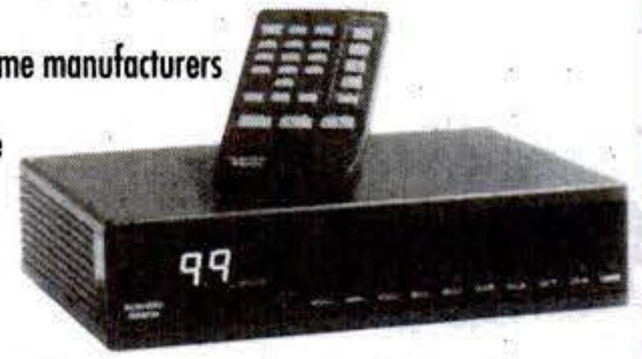
L&L ELECTRONICS INC.
1430 Miner St. Suite 522 Des Plaines, IL 60016
1-800-542-9425

Purchaser must agree to comply with ahh State and Federal laws regarding private ownership of cable TV equipment.

HOOK UP TO A GREAT MONEY-SAVING DEAL

Get the latest technology in cable converters and descramblers

- Best prices
- Save on equipment rental fees
- Quality merchandise by brand-name manufacturers
- Friendly personal service
- Thirty-day money back guarantee
- All orders delivered fast and conveniently via FedEx Economy Two-Day℠ service



You'll appreciate the premium view when you order from us! Call for free catalog

1-800-841-7835

CABLE BOX WHOLESALERS, INC.
460 W. ROGER RD. #106, TUCSON, AZ 85705

Plazac Sales, Inc.

1-800-A-WIRE-4-U
294-7348

JERROLD PANASONIC SA'S ETC CABLE TV CONVERTERS PLUS

•Special Dealer Prices! •Compare our Low Retail Prices! •Guaranteed Prices + Warranties! •Orders shipped immediately! C.O.D.

★ WE'LL BEAT ANY PRICE ★

Sorry no N.J. sales. Dealers Wanted.

MILITARY STYLE Model ROCKET LAUNCHER

Launch solid fuel model rockets!
U-Build with easy to find materials!
Detailed step by step plans!

only...$14.95
Check or Money Order
RICTON INDUSTRIES
Dept. GP
PO Box 870
Branford, CT 06405

CABLE TV BLOWOUT

NEW !!!

NOVAVISION & MILLENNUIM+

Revolutionary new universal one-piece converters and descramblers. Fully activates all Jerrold, Scientific Atlanta, and Pioneer systems except baseband. Options include:

- Picture in Picture
- Simultaneous watch/record
- Channel ID
- Volume/Mute
- Parental control
- On-screen display
- Stereo
- Last channel recall
- Favorite channel
- Ch 3/4 switch

All Other Models Available
30 Day Free Trial
1 Year Warranty

Best Dealer Prices Available Anywhere!

Jerrold, Scientific Atlanta, Pioneer are registered trademarks and all references are for identification purposes only.

"The Originals"

JERROLD® TvT & TnT
ACTIVATES ALL JERROLD EXCEPT BASEBAND

SCIENTIFIC ATLANTA® M80
ACTIVATES ALL SCIENTIFIC ATLANTA EXCEPT BASEBAND

NEW IMPROVED!!!
PIONEER® PIO-III+
WORKS ALL PIONEER SYSTEMS

Call for your FREE brochure today

MicroCom Inc.
800-665-2002

MasterCard • VISA • AMX • COD

Let us offer you a WORLD of savings..

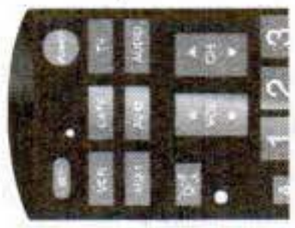
UNIVERSAL CABLE TV CONVERTER & Ddescrambler

WE CARRY ALL MAKES AND MODELS

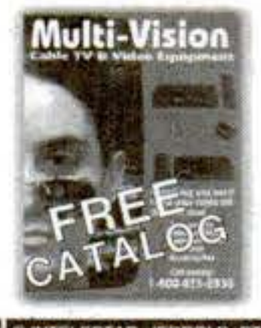
SCIENTIFIC ATLANTA® JERROLD® ZENITH®
PIONEER® STARGATE® INTELESTAR®

- Picture Improving Energizer Cables
- Video Stabilizers Universal Remotes
- Bullet Protectors & Immunizers

DEALER INQUIRIES WELCOME
FULL WARRANTY GUARANTEED!!



MEMBER OF THE NATIONAL CONSUMER CABLE ASSOCIATION



Order Toll Free: MasterCard VISA

1-800-835-2330

Order by C.O.D., Check-Via-Phone or VISA / MC
Please have the make and model # of the equipment used in your area.

© INTELESTAR, JERROLD, STARGATE, PANASONIC, ZENITH, PIONEER, SCIENTIFIC ATLANTA, TOCOM, & PICTURE-IN-A-PICTURE are all registered trademarks. All references to the above mentioned equipment is for identification purposes only, we are in no way implying that any of the products in our ad original equipment. Multi-Vision Electronics is in no way affiliated with the above mentioned companies or corporations.

BUY FACTORY DIRECT AND SAVE!

Patent Pend. **COVERIT™** INSTANT GARAGES ALL WEATHER SHELTERS — **2 YEAR WARRANTY** 30 DAY MONEY BACK GUARANTEE!

Starting At **$199** *PROTECTION FOR:* Cars, Trucks, RV's, **Boats,** Docks, Hot **Tubs, Greenhouses, Motorcycles,** Pools, **Paintbooth, Concrete,** Workshops, **Gov't and Industrial** Contracts, **Sandblasting, Camp or Temporary Shelter, Walkways, and** More! **HEAVY DUTY Steel Frame. Durable Dupont® Cover with Zipper Door. Sizes Available from 5'** to 60' Wide, **up to 30' High, Any Length. Withstands** Rain, High **Winds, Sun, Sap & Heavy Snow. No permit** Property **taxes or required. Assembles and Anchors** Easily. **Covers** last up **to** 20 **Years. We** Ship to Your Door!

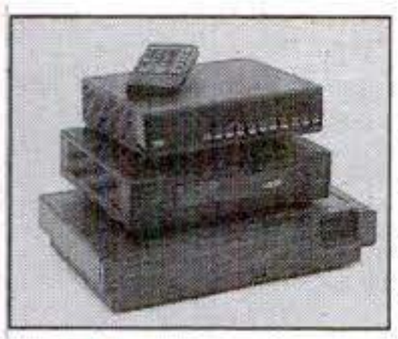
DEALERS & EXPORTERS WELCOME

CALL NOW Toll Free 1-800-932-9344 } Ext. 227
203-781-8000
FAX: 203-781-8005

Copyrighted material

Cable TV Descramblers *Converters & Accessories*

For the amount of money you spend each year on cable rental, you could own your equipment.



YOU NOW HAVE A CHOICE... save money by purchasing your cable equipment. **Access all premium** and basic channels. We offer the **lowest prices** on all major brand names including Zenith, Jerrold, Scientific Atlanta, Tocom, and Pioneer. **FREE 30 day trial period and 1 year warranty.** So, if you are tired of the rising cost of cable TV...

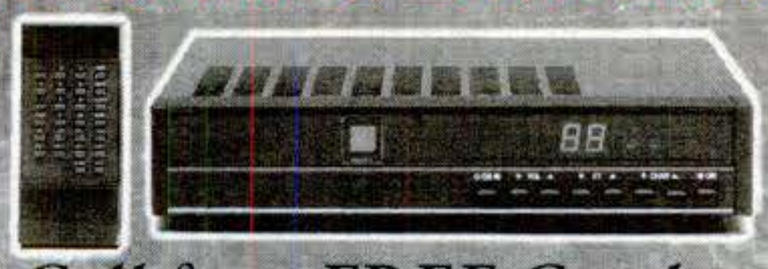
800/334-8475

Call for your free catalog today

MasterCard • VISA • AMX • COD

Add-on Cable Company

Converters and Descramblers



Call for a FREE Catalog

1-800-715-6789

Why Rent when you can Own?

Millennium ENTERPRISES

...It's Full of Stars

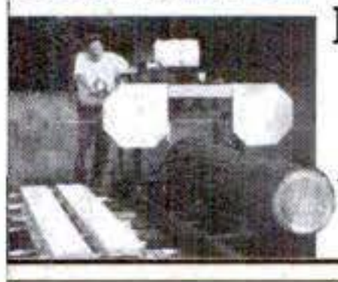
We offer a Galaxie of selections

- Panasonic
- Jerrold
- Pioneer
- Zenith
- Scientific Atlanta

DISCOVER VISA C.O.D MasterCard AMERICAN EXPRESS

13729 183 N. • Suite 610-124 • Austin, TX 78750

SAWMILL $3795.



FREE INFO

Silvacraft Inc.
90 Curtwright Dr.
Unit 3
Amherst, NY 14221
1-800-661-7746
Ext. 101

STORAGE BUILDINGS

Factory Direct

All Steel

American Made

Easy Do-It-Yourself Construction

25x30 Roof & Sidewall System
$4,155 Value NOW ONLY $2,347

Some other sizes available

Miracle Span

1-800-222-7885 PS

CAD DIGGER

Build It Yourself Backhoe • Free Brochure

Plans to build and use • Self propelled
• No machining • Car towable
• Under $1,200 to build
• In use over 8 years

CADplans

P.O. Box 606, Dept. S • Daleville, VA 24083 • 1-800-817-5267

CABLE TV DESCRAMBLERS

1-800-233-9388

FREE CATALOG

GUARANTEED BEST PRICES · IMMEDIATE SHIPPING

APPLE ELECTRONICS

3389 Sheridan St Suite 257 Hollywood FL 33021

SUMMER CLEARANCE!!!

STEEL BLDGS

SAVE UP TO 45%

Buy factory Direct: 16X 24 • 20 X 26
Build it yourself !!! 25 X 38 • 40 X 72
The Perfect Building For All Your Needs !!!
CALL TODAY **800-888-4606**

STEELMASTER

BEST DEALER PRICING!

30 DAY FREE TRIAL!

CABLE DIRECT

DESCRAMBLERS
CONVERTERS · FILTERS

COPY RENTAL TAPES WITH OUR
VIDEO STABILIZERS

Now you can tune-in to your favorite cable TV programming and SAVE $100'S - EVEN $1000'S on premium CALBE TV EQUIPMENT.
FREE Cable TV Catalog.

100% MONEY BACK GUARANTEE!

1 YEAR WARRANTY

MODERN ELECTRONICS
1-800-906-6664
2125 S. 156TH CIRCLE • OMAHA, NE 68130

Cable Descramblers

We'll beat anyone's price!

1 Year Warranty 100% Money Back Free Catalog

Filters * Converters * Accessories

ORION Electronics

1-800-379-3976

TOUCH-FONE NEWS

1-900-562-1900 ext.3600

Sports Scores and Trivia Buffs, Financial Headlines, Stock & Commodity Prices, Horoscope

• 15 MINUTE UPDATE •

$2.49/min.-avg. length of call, 3 min. 18 or older

Touch Tone Phone Required

TeleService USA, Hagerstown, MD 301-797-2323

NIGHTSCOPES INTERNATIONAL

C1 Model

Regular Price $379

Sale Price **$259**

Also On Sale!
B5 Unit...$949
NS1 Unit...$699

Long-Range-R Weapon Mount Units Available, Too!

- Factory Service • One Year Warranty
- Direct Factory Importers
- 10 Day Money-Back Guarantee

Write Or Call For Brochure

1-405-323-3555

PO Box 8, Dept. PS
Clinton, OK 73601 Fax: 405-323-6601

COMPUTER ERASE BAD CREDIT FREE

I N S T A N T L Y !

Add tens of years of AAA credit in your credit file

"OVERNIGHT". 100% Legal **FREE DETAILS**

FBI, DMV (DUI) Files too...

Gold (PS)
P.O. Box 15574
Beverly Hills, CA 90209

PERMA SHARP™ Mower Blades

NEVER NEED SHARPENING
LAST 3-5 TIMES LONGER
SEND SASE FOR DETAILS
BEBE MFG. BOX 403.
WEIRSDALE, FL 32195

CABLE TV DESCRAMBLERS

All major brands * Money-back guarantee
BELOW WHOLESALE PRICES * 2 YR. WARRANTY
ABSOLUTELY THE LOWEST PRICES!
WE BEAT ANY PRICE... NOBODY BEATS US!

RP ELECTRONICS
1-800-304-3604

An Affordable, Personal Helicopter

The Mini 500

Easily Built in One Week • Comes Complete
110 MPH Top Speed • Go Anywhere!!

Info Package Catalog	$15
Action Video	$30
Info Pack & Video Combo	$40
PAL (European Format) Video	$45
Info Pack & PAL Video Combo	$55

(Foreign orders add $10 for S/H)

For Customer Service or Questions Call (816) 637-2800

Revolution Helicopter Corp.
1905 W. Jesse James #PS
Excelsior Springs, MO 64024

Credit Card Orders Only:
1-800-637-6867

Elite Electronics

Descramblers Converters & More!

Free Catalog!

1-800-682-9968

Great prices without the hassle!

30 Day Money Back Guarantee
1 Year Warranty
1 Year Trade-up

2927 S. 120th St. Omaha, NE 68144

MIND MACHINE BUYER'S GUIDE

- ZYGON'S SUPERMIND™ & Learning Machine™
- SHARPER IMAGE™ S.I.R. • Synetics' MINDLAB™
- MindGearPR2-X™ • Comptronic's DAVID PARADISE™

THE MOST POWERFUL STRESS-REDUCTION, MEDITATION, CREATIVITY, AND SELF-IMPROVEMENT TOOLS AVAILABLE!

Scientific Researchers and Graduate Students CRITICALLY EVALUATE and COMPARE the most popular Mind Machines for:

- Valuable Features
- Effectiveness
- Product Quality
- Ease of Use

PLUS, where you can purchase new Mind Technologies ***FOR LESS!***

YOUR DECISIONS WILL BE EASIER ONCE YOU SEE IT ALL HERE!

Send Check or Money Order for $10.00 ($15.00 for Non U.S. Orders) to:
Neuro-Technology Research, Harvard Square
Dept. 14P, P.O. Box 1991, Cambridge, MA 02238
Credit Card Orders add $3.95 S & H. (800-646-3622)
Call 800-MIND MACHINE

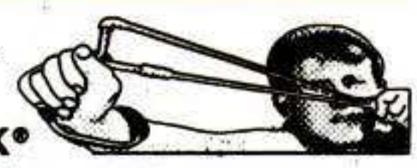
World's Smallest FM Radio

Now you can get stereo sound anywhere, anytime for just $17.95 + $2.00 S&H
Visa and MC accepted.

Call now +1 800/773-6447

Premier Specialty Sales
PO Box 40383, Eugene, OR 97404

TRUMARK®



225 Yard Range folding slingshot stores ammo in handle. Includes 70 rounds of 1/2" white Tracer® brand marbles, and extra band assembly. Post. paid **$15.00** total

TRUMARK® SNAPSHOT brand Rubberband Gun shoots 6 shots in rapid-fire action. Long 12" barrel snaps bands up to 30 feet. Black plastic stock & rotating starwheel. Includes 12 powerbands. **$12.95** postage pd. Send your check or money order to: **Trumark 1835-P 38th St. Boulder, CO 80301**

CREDIT CARD ORDERS : 1 800 878-6272

BUILD YOUR OWN ROCKET MOTORS!

- UP TO 80 POUNDS THRUST!
- USING SIMPLE MATERIALS!
- FOR JUST PENNIES APIECE!

Homemade rockets go together quickly. Use homemade fertilizer/charcoal fuel. Models fly thousands of feet! Speeds to MACH 1!

Write for our catalogue, and we'll send you a working sample of a homemade electric rocket igniter AND teach you how to make your own homemade rocket motor casings, all using materials you'll find around your house.

SEND $2.00 TO:

Dept. PS 7, THE TELEFLITE CORPORATION, 11620 Kitching, Moreno Valley, CA 92387

Copyrighted material

CABLE TV EQUIPMENT

Your #1 Source for Descramblers, Converters and Combinations

WE WILL

MATCH OR BEAT

ANY ADVERTISED OR WHOLESALE PRICE!

SAVE $$$ - DON'T RENT

CALL FOR FREE CATALOG!

Zenith, Pioneer, Tocom, Century, Jerrold, Panasonic, Oak Sigma, Scientific Atlanta and more!

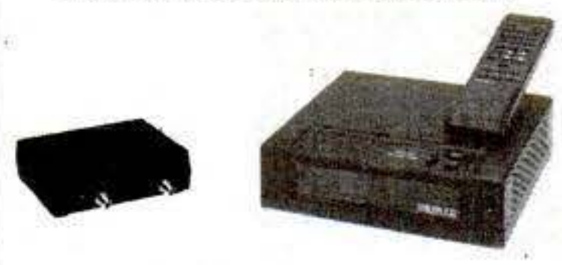
Call *AA Electronics* Today!

800-258-9512

CREDIT CARDS ACCEPTED

Cable TV Descramblers

We offer a full line of original and aftermarket descramblers for Jerrold, Pioneer, Zenith, Scientific Atlanta, General Instruments ...



GALT, INC.

CALL 800-487-2225

6325-9 Falls of the Neuse Road
Suite 310
Raleigh, NC 27615

KITES

FREE COLOR CATALOG

Choose from over 200 kites.
Many unusual & innovative designs.
Call or write for your catalog today!

Into The Wind • (800) 541-0314
1408-P Pearl St., Boulder, CO 80302

CABLE DESCRAMBLERS

No 800#
No Catalog
Just low, low prices.

Call the rest
Then call us for the best price.

305-425-0751

NO FLORIDA SALES!

"BLASTER" These are not toys!

Where the Sportsman shops!

Deluxe Precision Blow Gun – $9.95
36" aircraft aluminum tubing p&h $4
2 quivers

12 pre-sharpened darts
penetrate 1/4 plywood no problem
Deadly accurate at 100 feet
in 1/2 a second!! anti-inhale mouthpiece

"PRO-HUNT" Slingshot – $9.95
p&h $4

Free replacement band & 75 steel ammo!!

Pistol Crossbow – $17.95
p&h $5

Diecast Gun Body
Polyester String
Adjustable Sights
Safety Lock
5 Aluminum Arrows w/Steel Heads
Spare String–$4, Spare Bolts (12 pk.)–$7

Water Balloon Slingshots
p&h $3/ Launcher
90 yard – $10
120 yard – $11
150 yard – $12
200 yard – $14
144 Balloons – $3

Knife Sale! Your Choice – $8.95
p&h $3

Boot Knife or Multi-Function Hunting Knife
Both are 8.5" long —
Have Stainless Steel Blades & Sheaths!

Rush order to: BLASTER
13218 Jessica Drive
Spring Hill, FL 34609
M/C – VISA – 1-800-441-1047
Must be 21 years old to purchase
SATISFACTION GUARANTEED

VISA MasterCard

CABLE TV DESCRAMBLER SALE

Money Back Guarantee

1-800-535-1843

LOWEST PRICES!! Quantity Discounts!!
DEALERS WANTED 9-6 MON-FRI
EARN EXTRA $$$ SAT 10-2 CST
Please have MODEL used in your area when calling

Call us Last and Save!
CNC Concepts Inc
PO Box 49503-PS
MPLS. MN 55449

ALL TERRAIN VEHICLES

GO ANYWHERE!

max 6 wheel drive ATV

Amphibious 2 and 4 passenger models

(21-years-old and over, Please)
No Money Down. As low as $115 mo.
Call Toll-Free 1-800-255-2511
(From anywhere in the U.S. or Canada)
Recreatives Industries, Inc.
60 Depot Street, Buffalo, NY 14206

ALTERNATE ENERGY

SAVE UP TO 80% ON HEATING BILLS

Wood/oil, wood/gas multi-fuel whole house warm air furnace.

Eagle Furnace
1000 Ag Science Drive
Palisade, MN 56469
or 1-800-358-0060

Compressed Air Auto secrets, catalog $3.00, book $8.00, PneumOpt, 6333 Pacific, Stockton, CA 95207.

FREE ENERGY! Fuel-Less Motors and Generators! H&A, R2EPS Bowling Green, MO 63334-9350.

GIANT SOLAR PANELS $48.00! Catalog $4.00 QUAD ENERGY, P.O. Box 690073, Houston, TX 77269. 713-259-0393

NEW! BUILD AMAZING LIQUID PISTON ENGINE from pipe fittings. Free information. ABCO, Box 306-S7, Seminary, MS 39479

APPAREL

CAP SPOILER! New patented product. "Won't let your cap blow off your head in the wind." Money back guarantee. 2 for $9.99 plus $2.00 S/H. Call 800-996-6227.

ARTS & CRAFTS

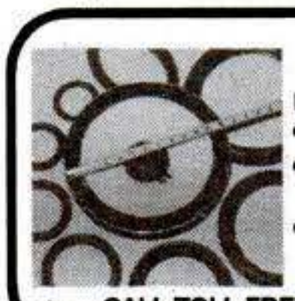
"GETTING Started in Stained Glass" $1.00. Whittemore, Box 2065X, Hanover, MA 02339

ASTRONAUTICS

30 ANTIGRAVITY METHODS! "FREE ENERGY" GENERATORS! 200 UNCONVENTIONAL TECHNOLOGIES! AMAZING ARCHIVES CATALOG! Send $2: Rexco, Box 19250, Jean, NV 89019.

THE SECRET SPACE PROGRAM. Book- $10, Catalog- $1. THE SECRET INFORMATION NETWORK. Box 3185, W. Sedona, AZ 86340

AUDIO/VIDEO EQUIPMENT



SPEAKER EDGES ROTTED

BEST WARRANTY • GUARANTEE!
- DIY Surround Kits Save Big $ $
- Full Service, Factory Authorized Repair. ALL major brands.
- In walls, ceiling speakers, replacement parts, grill cloth, rot preventative.

CALL TOLL FREE 1-800-767-4041
SIMPLY SPEAKERS • VISA/MC/DISC/AMEX

REPAIR FOAM ROT FOR YOURSELF!

SAT will save you hundreds of dollars! All sizes including AR, Advent, BOSE, JBL. Surrounds, adhesive & instructions: **$27.95**/pr. **BOSE 901's $67.95**/pr. (incl. S/H, No COD's) **Do it yourself with SAT!**

STEPP **AUDIO TECHNOLOGIES**
PO Box **1088, Flat** Rock, **NC 28731**
800-747-3692 MC/VISA
704-697-9001 **24 Hr.**
Incl. make & model w/order

HAIL NO! Portable, **Hail RESISTANT** Car Cover Plans. $12 to: BittoCo, P.O. Box 21036, Huntsville, AL 35824

AUTOMOBILES

Build Your Own Cobra.

It's fast, it's mean and its almost as much fun to build as it is to drive. Order factory direct from CARS Inc. Free Color Brochure, call:

(800)-252-7742 ext.9507

$50,000/ YEAR. Selling, wholesale, or exporting cars. FREE report. CODEX, 507 Oak, Friendswood, TX 77546

SAVE $1.000's ON AUTO PURCHASES, SPECIAL REPORT! SASE/$3.00 DIC, PO BOX 1001, BRANDENBURG, KY 40108.

AUTOMOBILES

CARS FOR $100! Trucks, boats, 4-wheelers, motorhomes, furniture, electronics, computers etc. by FBI, IRS, DEA. Available your area now.Call 1-805-962-8000Ext.s-20025

CARS FOR $100! Trucks, boats, 4-wheelers, motorhomes, furniture, electronics, computers etc. by FBI, IRS, DEA. Available your area now. Call 1-805-962-8000 Ext.s-20025

Check/ Service Engine Light ON? Easily Diagnose using car's computer manuals for Ford, GM, or Chrysler. $8.50 each. Box 4044, Waterbury, CT 06704

FUEL ATOMIZER 2000. Famous, small and doubling gas mileage for many. Save gas and earn money. Costs less than $150.00. Guaranteed. Free Information. 800-647-1771. 24hr recorded message. WYOMING INSTRUMENTS - A NAME TO BE TRUSTED.

VAPOR CARBURETOR TRIPLES MPG. Free information. H&A, R2PS Bowling Green, MO 63334-9350.

AUTO SUPPLIES & EQUIPMENT

DOUBLE THE LIFE OF YOUR CAR! Tips on finding a great cheap Mechanic. Money saving coupons. Money Back Guarantee. Manual $14.95: Cars Life, 112 Pickney suite 43, Boston, MA 02114.

AVIATION

World's Tiniest **HOMEBUILT HELICOPTER**

Super-low-cost, easy construction!

This tiny marvel flies like the big ones, yet is the smallest & simplest piston-engine helicopter ever developed!
- Carries one person
- Can be stored anywhere
- Powered by Go-Kart engines
- No license needed

G-1 Construction Plans: Only $24.95
(Add $3 post. Foreign add $6)
Your order includes a Helicopter Experimenter Book and a Homebuilt Helicopter Catalog
Catalog only: $10

VORTECH, Inc.
PO Box 511-A
Fallston, MD 21047
Orderline: 1-410-583-6366

Low Budget **HOMEBUILT ULTRALITE** Anti-Stall & Spin Design

Experience the freedom of open sky *Easily built in one Week !!*

No License needed
Build this simple plane using urethane foam and wood Propulsion options range from go-cart engine to Rotex power

Empty Weight : 150 lb
Max. Speed : 60 mph
AEROTEK ENGINEERING, Inc.
14019 S.W. Fwy, #301-260
Sugar Land, TX 77478

Complete & Fully Illustrated
PLANS $15 + $ 3 postage
Includes a Ultralight Guidebook & Homebuilt Ultralight Catalog

MICRO HELICOPTER
Designed by NASA Engineers
Complete unit, parts available
Fully assembled under $900

MOST INNOVATIVE DESIGN
Rotor turned by two opposed gas engines.
Eliminate tailrotor, clutch, reduction gears & assoc. linkages .....
Fully illustrated & Detailed
PLAN $ 15+ $ 2 postage
B-EZ Engineering P.O. Box 1675, Stafford, TX 77497

Cycle-Flyer MAN POWERED SAILPLANE
Kits from $499
Glide Ratio of 35:1@ 250 lb
Lightweight, Low Cost and Easy to Build

Complete Blue Prints & **PLANS $ 14.95**
add $ 3 postage
(foreign add $ 5)
Cycle-Flyer, Inc.
19672 Stevens Creek, #264, Cupertino, CA 95014

Incredible 20 PROJECTS of PVC PIPE

GO-KART/ BAJA/ HOVERCRAFT/ SNOWMOBILE/ LANDSAILER, SAILBOAT/ GREENHOUSE/ SWIMMING POOL/ & MORE.

PVC PIPES ARE EASY TO CUT/FIT/ALIGN /JOIN GOOD-LOOK & DURABLE

BOOK $ 14 + $3 postage
Collection of detailed plans for all 20 projects.
PVC DESIGN P.O. Box 36674, Houston, TX 77236

AIRBOATS - Hovercraft - Airdrives. Propellers, Engines, Plans. Catalog $5.00. Arrowprop, Box 610P, Meeker, OK 74855.

BALLOON FLIGHT VIDEO. From Pilot's Viewpoint. During Abq. Balloon Fiesta. $22.95. Box 76552 Oklamona City, OK 73147-2552

Copyrighted material

AVIATION

BUILD YOUR OWN *LIQUID FUEL*
ROCKET ENGINE!
- Uses regular gasoline as a fuel!
- Re-usable ! Use it over and over!
- Can reach altitudes up to 5000 feet!

Professionally engineered and designed! Plans include detailed drawings to construct engine, rocket casing and parachute recovery system. Complete parts and suppliers list included. Instruction manual, blueprints and parts list; $18.95. Send to;

Systeme Solaire
4414 Notre Dame, Chomedey, Laval
Quebec, Canada H7W - 1T6

MAKE YOUR OWN *FLYING* MODEL HOT-AIR BALLOON
~ using easy to follow plan
~ with easy to find materials
~ that stands over 30 inches!

SEND CHECK/M.O. FOR ONLY $12.95 TO: ORDER TODAY !!!!
SCAYPE PLANS
P.O. BOX 383
GRAYSLAKE, IL 60030
AWESOME! CAN FLY FOR MILES!

GYRO COPTER *Explore the sky!*

- Low cost
- East to assemble
- No license needed
- 1000+ Plan built flying

FREE GYRO GUIDE BOOK & HOW TO FLY GYRO WITH YOUR ORDER

Build a L.A. gyro from our plans

L.A. Gyro, Inc.
1429 E. Valley Blvd. # 349
Alhambra, CA 91801

Complete set of detailed **Plans** $14.95 plus $3 S/H

Jet POWER! Up to 37 lbs. of thrust!!

BUILD THIS AMAZING JET ENGINE IN YOUR OWN HOME SHOP!
Jet power for • 1-PERSON HELICOPTERS • AIRPLANES • JET PACKS • GO-KARTS • BIKES • ROCKETRY

SUPER BONUS *How to Build a Jet Helicopter!* FREE WITH YOUR ORDER! (A $15.00 Value)

Complete Pulsejet Plans ONLY $20.95 plus $3 p/h — $6 foreign

Order from: **Windspire**
PO Box 145 • Dept S
Long Green, MD 21092

For credit card orders: (410)836-6824

BOOMERANGS! **HI -TECH DESIGNS.** Amazing Science Project Fun...Returns! FREE Catalog. BoomerangMan, 1806-2 N. 3rd, Monroe, LA 71201-4222.

BUILD/FLY Your own **BACKPACK POWERED PARACHUTE** for fun/profit. Takes off from level ground unassisted. Safe, Simple, Inexpensive. Detailed book with sources. Now only $19.95 ASYUP 1089 Medford Center #244s, Medford, OR 97504

HOVERCRAFT

FAST, SIMPLE, QUIET HOVERCRAFTS. 18 designs. Catalog $2.00. Box 281 Cordova, IL 61242

BEER & WINEMAKING

BEERMAKERS Winemakers Free Catalog. Fast Service, Free Recipes. Cellar-S, Box 3525, Seattle, WA 98133. 800-342-1871

BEGINNERS **SPECIAL,** Free Catalog and Great Prices. Call **U-BREW** 1-800-845-4441, North Myrtle Beach, SC 29582.

Homebrewers. FREE CATALOG. Great Beginner kits. Brewery, 1304 Quincy, Minneapolis, MN 55413. 800-234-0685.

WINEMAKERS - **BEERMAKERS**. Free Illustrated Catalog. Since 1967. 1-800-841-7404. KRAUS, Box 7850-N, Independence, MO 64054.

BETTER HEALTH

I SMOKED 4 packs/day. **"HOW I QUIT."** Starting. $5.00 FAB Box 189 Hilton, NY 14468

NATURE'S **MAGIC STRYRAX BENZOIN-** ancient remedy for athlete's foot-- still effective when used in massage with natural lubricant. For brochure send $2. Box 195 5261 Highland Rd. Baton Rouge, LA 70808

BOATS, MOTORS & EQUIPMENT

BOAT KITS -- PLANS -- PATTERNS -- EPOXY -- FIBERGLASS -- SUPPLIES -- 250 DESIGNS -- 6'/70' -- Powerboats -- Sailboats -- Hydroplanes -- Tunnelhulls -- Canoes -- Kayaks -- Dinghies **-- CATALOG -- $2.00.** BOOK "Amateur Boatbuilding" -- $6.00. **CLARKCRAFT,** 16-7 Aqualane, Tonawanda, NY 14150.

BOAT PLANS - PATTERNS - KITS - 168-page **DESIGN BOOK-$5.00 GLEN-L.** 9152 Rosecrans, Box 1804/PS5, Bellflower, CA 90706-2138. 310/630 6258.

BOOKS & PUBLICATIONS

Back Pain? Proven video guarantees relief or your money back! FREE information (800)765-2502.

HOME REPAIRS? DO IT YOURSELF AND SAVE. 380 PAGE VOLUME EASY INSTRUCTIONS WITH ILLUSTRATIONS $16.95 + $4.20 S/H: R & E COMPANY, 321 QUEEN ANNE DRIVE, SLIDELL, LA 70460.

How to Open A Home Inspection Business, step by step, comprehensive, covers technical, marketing, product info, business nuts and bolts, includes FREE on-site inspection report, over 550 pages. $49.95, 800-454-6775.

BURGLAR/FIRE ALARMS

Free Wireless Driveway Alarm Literature SASE. Nielsen, Box 158, Lake Benton, MN 56149.

BUSINESS OPPORTUNITIES

T-SHIRT PRINTING MACHINE

We manufacture professional single and multi-color screen printing equipment. Inexpensive. Call for brochures, prices and information pack on the versatile AZTEC 1000 T-SHIRT SCREEN PRINTER.

CATCO MFG. CORP. MIAMI, FL **800-869-6338**

CRACK REPAIR OVER A FOOT LONG

PATENTED PROCESS **HUGE DEMAND!** JUST LOOK AROUND YOU

Ultra B-O-N-D,® Inc.
1 (800) 347-2820
3696 Beatty Drive, Riverside, CA 92506

Be Your Own Boss — Determine Your Own Future

EARN $60,000 YEARLY

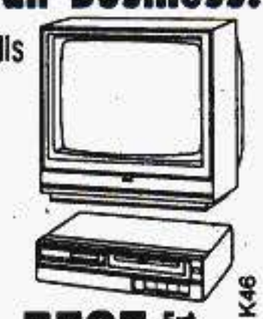
Repairing (not replacing) stone damaged windshields and plate glass. Learn how a 3 minute repair can earn you $1200/week!

CALL NOW! 1-800-695-6224
FREE REPORT!
NVS/OPTIKLEER, LYNN, MASS. 01904

GREAT FULL OR PART-TIME CAREER

Start A Money-Making TV/VCR Repair Business!

Learn the technical skills you need to start your own business. No experience necessary.



For FREE Facts, Call Toll Free:

1-800-595-5505 Ext. 7836

OR SEND ENTIRE AD TODAY!

K46

ICS **International Correspondence Schools**
Dept. APC065S
925 Oak Street, Scranton, PA 18515

Name_____ Age___
Address_____ Apt.#____
City/State_____ Zip_____
Phone ( )_____

BUSINESS OPPORTUNITIES

BE YOUR OWN BOSS

Repair Cracked Windshields. It's Easy. We'll teach you how to start and run your own business. Keep all the money you earn. Patented Equipment. FREE valuable report.

CALL 1-800-321-2597
GLAS-WELD SYSTEMS, INC.
Box 5755-C • Bend, OR 97708

---

4 WHEEL BIKE
DRIVES LIKE A CAR!

Stable • Street Legal
Easy to Pedal
Comfortable
1, 2 & 4 Seater
Golf Bag-Cargo Carrier
Free Literature 24 hr. 1 (615) 822-2737 Ext. 5782
RHOADES CAR DEPT. 5782 • 125 RHOADES LN HENDERSONVILLE, TN 37075

REPAIR CRACKED WINDSHIELDS

Earn $90,000 Yearly Repairing
-not replacing-
Large Cracks in Windshields
CALL 1-800-826-8523
or write The Glass Mechanix Inc.
4555 NW 103rd Ave. • Ft. Lauderdale, FL 33351

EASY TO RAISE AUSTRALIAN FRESHWATER LOBSTERS and GIANT CALIF. EARTHWORMS.

Over 60 pages of exciting information and contract. Raise in your own backyard, cellar or garage. Fast growers and big money makers. Lobsters can grow up to 5 lbs. Desperately need earthworm growers to fill million dollar organic fertilizer contract. Worms up to a foot long. Send $10.00. Applicable towards 1st order. In Business Since 1931.

HY HUNTER INDUSTRIES
12001 Highwater Road • Granada Hills, Calif. 91344
(818) 363-0202 PH • (818) 360-8562 FAX

OUTRAGEOUS BUSINESS OPPORTUNITY, IN THE 900 BUSINESS, EXCELLENT INCOME POTENTIAL! FREE REPORT REVEALS 708-527-8659 24hrs

---

$100,000/ Year! Using Aerial Blimp Photography. Free Details. Blimp P.O. Box 687, Ozona, FL 34660

$1'000's WEEKLY MAILING LETTERS. FREE POSTAGE/SUPPLIES. RUSH S.A.S.E. COLOSSAL Box 040215-PS, BROOKLYN, NY 11204.

#1 MONEY MAKER Spare Time! No selling! No inventory! Publicly documented seven week $19,919 income! Free audio cassette and Report reveal everything. Real Money, 333-PS65 SW 5th Street, Grants Pass, OR 97526.

$2,000 DAILY From your Telephone Answering Machine! I've made over $1,000,000 using mine! (303) 637-1492. Recorded Details.

$2000 weekly!... Thousands satisfied homeworkers. Free infopak... **bonuses!** Universal-M, Box 360378, Brooklyn, NY 11236

$225 DAILY "CHROME PLATING" AUTO PARTS, MOTORCYCLES, INEXPENSIVE, EASY (FREE) information: Chrome, Box 5748, Deltona, FL 32728.

$25.00 / POUND PAID For Aluminum Scrap? (Yes... Free Report!) Write: Ameriscrap- PS795, Alexandria Bay, NY 13607-0127

$30,000 MONTHLY GOLDPLATING. Auto Emblems, Jewelry, Inexpensive Home Setup. Send $4.00 Gold, 424 Hill, Houston, TX 77037

$360,000 OVERNIGHT! Start-Up Cost: Zero! Amazing recorded message reveals details: (303)637-1493.

$392.00 from sq.ft. plywood.(HUGE DEMAND) Revealing proof-$1.00(Refundable). Woodwins-PS, POB 859, Bridgewater, MA 02324-0859.

$4000 Monthly posting ads for mail order company. No inventory, selling. Call True Alignment at (800)831-3255 for information.

BUSINESS OPPORTUNITIES

$40,000 ON 1/3 ACRE! New hydroponics - inexpensive, pleasant, practical! Free information. Planter's, Box 681804, Franklin, TN 37068-1804.

---

600 HOME BASED BUSINESSES REVEALED. FULL INFORMATION ONLY $29.95. MOON, BOX 1381, DICKINSON, TEXAS 77539.

A Millionaire This Year From Zero! Amazing Secrets Revealed! Start Now! Free details! Permanand Publications-PS, 919 Spoonbill, Ft. Lauderdale, FL 33326

ARAB BUSINESSMEN have money to buy and invest. Top finders fees paid. IMEA. 795ps1. Box3574, Newport Beach, CA 92659-8574, 714-722-9260

Are you hungry for success? Possibly make $5,000 per month distributing wild organic products. Call 800-298-4087

Build your own golf clubs! Free full - line catalog: heads, shafts, grips, tools, supplies and more. Call 1-800-423-2968.

Disappointed with MLM earnings? We have found it! No Inventory! No Fees! Big$$4U! 100% Guarantee. 1-800-777-7251

EARN AMAZING PROFITS! PERSONAL, HOME AND AUTO SECURITY PRODUCTS, FREE CATALOG 800-653-3012.

EASY! BECOME CURRENCY EXCHANGE PROFESSIONAL. Manual. Send $10.00. Planbiz Research, 15303 NSR121, Gainesville, FL 32653

Electroplating catalog Kits, Books. Info: University Publishing, POB 1071, Provo, UT 84603

EXCITING PROFITS from casino gaming. They can be yours! For key information sources you need, call 1-800-941-5777 today

---

EXTRA INCOME $2000 **MONTHLY Stuffing Envelopes SEND** $3.00 **M. KRAHN,** BOX 1732, Sumas, WA 98295.

FAMOUS MAILORDER MILLIONAIRE reveals money-making secrets! Free exciting cassette. Melvyn Powers, 12015 Sherman Rd., North Hollywood, CA 91605.

FREE! 1001 Fast, Easy ways to make money. Send name/address. Money Making, Dept. PS, Box Z Studio City, CA 91614

Free 900#'S- We're Giving Them Away! Outstanding Income Opportunity! Free Information: 914-573-2067

FREE! Turn any Computer into a **Money Machine. Free** Report: 1-800-221-3813 OperPS101

GET PAID $268.20/ Roll Taking Easy Snapshots! Film Supplied. Phototek, Box 2457-PS, Pinecove, CA 92549. 909-659-9757

GET RICH SELLING BOOKLETS BY MAIL. Expert reveals money making secrets. FREE exciting details. Lehigh. Box 3362. Allentown, PA 18106-0362.

Help others improve their health. BIG MONEY! Great product 1-800-341-0345 -- Anytime.

HOT BUSINESS ideas. Quick money. Amazing opportunities. Fabtronics 5714A Wautoma Hilton, NY 14468

HYDRAULIC JACK REPAIR MANUAL AND CATALOG $10.00. HYDRAULIC **PARTS SUPPLY, BOX 4157, BROWNSVILLE, TX 78523-4157.**

JOIN HOME-WORKER'S **ASSOCIATION** -- Get "Guaranteed Legitimate" home-employment offers! (Many Choices!) Write: Association PS795, Alexandria Bay, New York 13607-0250

LET THE GOVERNMENT FINANCE your small business. Grants/loans to $500,000.00. Free recorded message: (707) 448-0270. (JG6)

BUSINESS OPPORTUNITIES

MAILORDER OPPORTUNITY: Start profitable home business without experience or capital. Free book. Mail Order Associates. Dept. 482, Montvale, NJ 07645

MAKE $15,000 monthly! The Perfect Business. No investment. Easy. Free Booklet. MPC, Box 57, Lenore, ID 83541.

MAKE HOMEMADE "how-to/ opportunity" booklets. Mine have earned $820,644! Money never stops! Free report. Don Massey, 507M Oak, Friendswood, TX 77546.

MAKE MONEY NOW! Info $1.00 + S.A.S.E: J&C Enterprise, P.O. Box 2571, Hendersonville, TN 37077-2571

MONEY MAKING MACHINE. Curbmate machine installs beautiful concrete lawn edging. Amazing profits. 801-262-7509.

NEW 2000% PROFITS --in moldmaking/ Casting. Free information: Caster, Box 16586(P7), Memphis, TN 38186-0586.

NEW! GROW EXPENSIVE PLANTS, 2000% PROFIT. Free information. GROWBIZ, Box 306-S7. Seminary, MS 39479.

OWN YOUR MAIL ORDER BUSINESS SELLING BOOKS. TPCE, BOX 4113, TORRANCE, CA 90510

PIANO TUNING PAYS: Learn with approved home study course, Diploma granted. American Tuning School, 17050 Telfer Dr., Morgan Hill, CA 95037.

REALISTIC HOME BUSINESS/LONGEVITY Research- 30 pages. Send 2 stamps. ODESSA FACTSHEET, 3062-P Emerson, Palo Alto, CA 94306-2357.

RECORD VIDEOTAPES - At Home. $5,000 Monthly Possible. No pornography. Free Details. Write: CMS Video Company, 210 Lorna Square - #163P, Birmingham, AL 35216

RECYCLE (AMAZING PROFITS MADE) Reconditioning Automoblie Batteries! (Free) Information! Battery Outlet, Box 3300PS, Hickory, N.C. 28603-3300

SET YOURSELF UP FOR LIFE! $9,000 a month starting from "0"! PRC Inc, RT.3 Box 325 A-PS, Amherst, VA 24521

TYPING- Hand Addressing. $500 Weekly possible. Write: National, Box 104-P.S., Island Park, New York 11558-0104

YOU HIT A GOLD MINE. Earn 60,000 a year Gold Plating Emblems Or Automobiles. For Free Information Call US/Canada 1-800-877-0066 Write: The Gold Mine, 1304 S.W. 160th Avenue, Suite 230A, Ft. Lauderdale, FL 33326

BUSINESS SERVICES

SOCIAL SECURITY DISABILITY CLAIMS- for assistance call 1-800-889-1948

BUY IT WHOLESALE

Computers, communications equipment, and much more. Import-export specialists. AUDIO AMERICA (Virginia). 1-703-745-2223.

FAMOUS NAME REPLICA WATCHES. Authentic re-creations. Excellent quality. Wholesale prices. Brochure. 1-800-553-4334.

FREE 600,000 ITEMS, Wholesale Directory (LSASE) TNT, Box 2614P, Big River, CA 92242

QUALITY BUSINESS CARDS, SELF-INKING RUBBER STAMPS 50% OFF! FAST-FREE DELIVERY! 1-800-526-2348.

WHOLESALE Bargains, Freebies, Giveaways. Closeouts. 90% savings. Wholesale, Box 51488-Y, Ontario, CA 91761

CABLE EQUIPMENT

CABLE DESCRAMBLERS. BUY DIRECT-ROCK BOTTOM PRICES! NO CATALOGS, JUST LOW PRICES. CABLE OUTLET 1-800-203-7077.

CABLE EQUIPMENT

Cable TV Descrambler
NEW Product
No Converter Necessary
Works With All Systems
1-800-886-8699

CABLE T.V.

J.E.S. INC. ORDER NOW TOLL FREE!
1-800-676-7966
ALT: 1-800-804-6552
C.O.D.
It is not the intent of J.E.S. Inc. to defraud cable systems. Users are advised to check local and Federal Laws.

CABLE EQUIP.
REPLACE ALL MODELS
MONEY BACK GUAR.
1 YR. WARR. FREE CAT.
LOW PRICES • AVOID RENT FEES
1-800-243-3967
SKYLINE SYSTEMS, INC.
114 S. Euclid Ave.
Park Ridge, IL 60068

****CABLE T.V.****
DESCRAMBLERS
CFS ELECTRONICS
1-800-995-1749
VISA, MC, AMEX, COD

CABLE/ SATELLITE DESCRAMBLING. Real technical information. Free Catalog. Voice/ FAX/ BBS 716-874-2088.

CABLE Test Chips. Puts cable box into full service mode! $29.95 to $59.95. 1-800-452-7090, (310)902-0841.

CABLE-TEST CHIPS As low as $9.95 For Testing Cable Boxes in Full Service Mode. JERROLD; PIONEER; PIONEER CUBES; TOCOM 5503/5507; SCIENTIFIC ATLANTA; ZENITH; REMOTES $10; **NE ENGINEERING** 800-926-4030

CABLE T.V. CONVERTERS AND ACCESSORIES. Fair Prices, Quality Service, and 14 years Experience Gives Us The **ADVANTAGE. CALL 1-800-952-3916** V/MC/AMEX/DISC/ COD. Advantage Electronics, Inc. 1125 Riverwood Dr., Burnsville, MN 55337. **MEMBER OF NCCA**

CABLE T.V. CONVERTERS AND DESCRAMBLERS. WHY RENT? CALL BASIC ELECTRICAL SUPPLY. 1-800-577-8775

CABLE TV CONVERTERS/ DESCRAMBLERS. Don't Pay Retail Buy From The Wholesaler. 30 Day Money Back Guarantee. No PA Sales. **DIRECT CABLE SUPPLY INC. 1-800-808-3356**

CABLE TV DESCRAMBLERS/ CONVERTERS. Jerrolds, Scientific Atlantas, Pioneers, Tocoms, Zeniths. **BEST PRICES!** Free Catalog! **ALLSTAR 800-782-7214**

CABLE TV DESCRAMBLERS. ALL MAKES. IMMEDIATE SHIPPING. VISA/ MC/ COD. WING WHOLESALE 800-304-4408.

CABLE TV EQUIPMENT & ACCESSORIES Wholesalers Welcome! 30 Day Moneyback Guarantee! Free Catalog! **PERFORMANCE ELECTRONICS, INC. 1-800-815-1512.**

CABLE EQUIPMENT

CABLE TV BOXES
JERROLD ZENITH TOCOM OAK SIGMA
Get the Clear Picture
HAMLINE PIONEER SCIENTIFIC ATLANTA
\$AVE RENT \$AVE RENT
FACTORY DIRECT! FREE 30 DAY TRIAL FRIENDLY SERVICE
VISA - MC - COD
1-800-833-1606
MICHAEL'S ELECTRONICS
DESCRAMBLERS

Cable TV DESCRAMBLERS!
These are the ones you've been Looking for!

WE CARRY A COMPLETE LINE OF ALL MAJOR BRANDS, INCLUDING TURN-ON CHIPS. WE HAVE THE *LOWEST PRICES!!*
VISA MasterCard COD **CATALOG AVAILABLE**
OVERNIGHT SHIPPING AVAILABLE ON MOST ORDERS.
1-800-618-7480 ORDER NOW!
National Electronic Wholesalers ★★★★★

CABLE HACKERS HANDBOOK
FASCINATING NEW BOOK REVEALS ALL!!
IF YOU OWN A DESCRAMBLER, OR ARE CONSIDERING THE PURCHASE OF ONE, THIS BOOK IS A MUST!! GUARANTEED TO SAVE YOU AT LEAST $100.00 ON THE PURCHASE OF A BOX, OR YOUR MONEY BACK! COMPLETE GUIDE COVERS EVERY ASPECT OF DESCRAMBLERS, AND HOW TO GET THE RIGHT EQUIPMENT MATCH THE FIRST TIME, WITH NO HASSLES. DON'T GET RIPPED OFF. READ THIS BOOK BEFORE YOU BUY!
TOPICS COVERED INCLUDE:
INSIDE INFORMATION FROM THE CABLE COMPANIES • GETTING THE RIGHT BOX • PRICE GUIDELINES • WHOLESALE OUTLETS REVEALED • BUY WHERE THE DEALERS BUY • TURN-ON CHIPS & INSTRUCTIONS FOR EVERY KIND • LEGAL ISSUES • HOW TO BECOME A DEALER • AND MUCH MORE!!
Get This Book Before they Ban It!!
ONLY $19.95 Plus S & H ORDER TODAY! VISA
1-800-618-7480

CABLE TV New products. Best in the business. External activators for Jerrold. Pioneer, Scientific Atlanta living or dead. Save Big. 800-375-7022

CABLE TV, ORIGINAL EQUIPMENTS, DESCRAMBLERS, CONVERTERS, COMBOS, QUANTITY DISCOUNT, CALL NOW WE'LL MEET OR BEAT THE COMPETITION UNIVERSAL SALES 800-647-2371

CABLE T.V. CONVERTERS, DESCRAMBLERS. Scientific Atlanta, Zenith, Jerrold, Pioneer, Oak. Replacements for most models. Quality, Price and Service. Visa M/C. Dealer inquiries invited. **EAGLE** Electronics Inc., **1-800-259-1187**, Number One, 1301 Railhead Blvd., Naples, FL 33963.

DESCRAMBLERS. Every Model Available. Call To Learn All Your Options. Sunstate Engineering. 1-800-717-1575

Descrambler Anyone can build with seven parts from Radio Shack- Plans $8.00 1-800-818-9103.

If you have beeping or chirping sound on some of your scrambled channels we can help. Call "The Filter Company" 1-800-820-8884 Ext #777.

Link Yourself To The Future With Our Experience! Cable TV Converters And Descramblers. Quality, Service And Satisfaction Guaranteed! Visa/MC Amex C.O.D. Accepted. Quantity Discounts. **CABLE LINX, Inc** MPLS, MN **1-800-501-0095**

PROTECT YOUR INVESTMENT. THE SURGE ENDER Electronically Neutralizes Any Harmful "Surges" Sunstate Engineering 800-717-1575

R2/V5/CFT 1 Wire HRC/STD Ch. 3&4. Fast Version. Limited Time Offer. **$14.00 Minimum 10. 1-800-831-2050**

Revolutionary Technology: Universal Box Works On Jerrold Or Pioneer Systems 1-800-676-6342.

SCIENTIFIC ATLANTA, PIONEER, AND **JERROLD COMPATIBLE DESCRAMBLERS. NEW** EQUIPMENT. **ONE PIECE.** CALL EVERYONE ELSE, THEN CALL US FOR THE **BEST PRICE.** NO CALIF. SALES. **ACME CABLE PRODUCTS **1(800)866-ACME****

TEST CHIPS All brands of test chips. Put your box in full test mode call 303-731-9400

CABLE EQUIPMENT

SECRET CABLE DESCRAMBLERS! Bui your own Descrambler for **LESS** than $12.0 in **SEVEN EASY STEPS! RADIO SHAC** Parts List and **FREE** Descrambling Metho that **COST NOTHING** To Try, Included. Sen $10.00 to: **INFORMATION FACTORY,** P.O Box 669, Seabrook, Texas 77586. For C.O.D 1-713-922-3512 Any Time!

SUPER CABLE TV "TURN-ON CHIPS." Pro vides Full Service Activation. **FACTORY D RECT!! EXCELLENT INSTRUCTIONS!** JER ROLD, TOCOM, ZENITH, PIONEER SCIENTIFIC ATLANTA. **CALL NOW!! MAS TER COMPONENTS. 800-233-0570.**

TEST AIDS ALL TYPES RFT1's, FTG's, AN CUBES. TEST CHIPS. 1-800-671-111 (808)671-1110.

Tocom 5503 with Remote-$125. ea.. Bulletpro 5 @ $95. APEX 1-800-219-8618.

UNIVERSAL DESCRAMBLER Original RFT Premium Quality Accept No Imitation Com patible With **Jerrold** DPV7 DPBB7 CFT. Cab **TV Descramblers. All Brands** Availabl **1-800-717-5003.** MC/VISA.

CATALOGS

RAISE FISH AT HOME For a 190 page Aqua culture Products Catalog, packed with 2,000 products, photos, descriptions, technical info mation and insight into the fish farming industr send $6 to Aquatic Eco-Systems, Dept.PS 176 Benbow Court, Apopka, FL 32703

CB RADIO/SCANNERS

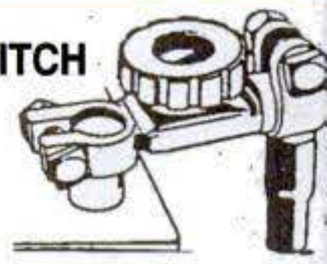
POLICE - FIRE SCANNERS, CB'S MARIN 2-WAY, **ANTENNAS, HPR, BOX** 62113 LITTLETON, **CO 80162.**

PRO CB ANTENNAS/ACCESSORIES! Fre Catalog. Firestik Manufacturing. 2614 E Adam Phoenix, AZ 85034

SECRET Scanner Frequencies: Federal, Police etc. Catalog $1.00! CRB, Box 56PS, Commac NY 11725

CLASSIC CARS

BATTERY MASTER SWITCH



Patent Pending

Can fit post, lug or side terminal batteries

Disconnects all electrical circuits with a simple turn of the knob. Attaches to battery in minutes. Heavy duty. Suitable for 12 or 24 volt batteries.

Eliminates battery drain, prevents electrical fires, provides emergency cut-off.

Remove knob to stop theft and unauthorized operation. **$14.95 each postpaid**
Add $1 for side post adapter
BATHURST, INC.
Box 27-PS, Tyrone, PA 16686
814-684-2603
Quantity discounts-12 units or more.

COMPUTERS

ANARCHY ONLINE: Controversial and unusu information online. Telnet: anarchy-online.co Modem: 214-289-8328

$$$MAKE YOUR PC ENERGY EFFICIEN Includes Windows 3.1 software and hardwar $129.95 ORDER NOW! 1-800-634-9778 Mi roGreen Products, Inc.

COMPUTERS/INTERNET

GETTING ONLINE IS EASY! Free trial membe ships from major services including Intern access. $15.00 package contains softwar information. Capital Ventures, POB 820. Youn sville, NC 27596.

Copyrighted material

COMPUTER SOFTWARE

ARTIFICIAL INTELLIGENCE for your IBM-PC. Call 718-898-3126 anytime for fascinating FREE 96-Page Catalog.

FREE CATALOG. IBM Compatible Shareware. **CALOKE INDUSTRIES,** Box 18477, Raytown, MO 64133. 816-478-6185

CONTACT LENSES

BUY YOUR CONTACT LENSES (ALL BRANDS) AT WHOLESALE PRICES. 70% SAVINGS, EXAMPLE-DISPOSABLES @ $17.00. INFORMATION 800-521-3511

DO-IT-YOURSELF

DON'T THROW AWAY THAT USED COPIER OR PRINTER CARTRIDGE!

Do it yourself it's easy

REFILL IT SAVE OVER 75%

Complete kit includes
- Toner Recharger
- Replacement felt
- Instructions

MORACK INCORPORATED
9132 Windsor Dr.
Palos Hills, IL 60465

Order or Information
(708) 598-0580
FAX (708) 598-9203

CANON® COPIERS PC 1,2,3,5,6,7,8,10,14,20,24,25 **$19.95**

LASER PRINTERS **$19.95**

SHARP® COPIERS 250, 55, 70, 75 **XEROX® 5008** **$29.95**

SURVEILLANCE

Hidden Video• Electronic Kits • Shotgun Mics
Vehicle Tracking • Voice Changers • Caller ID
Bug/Phone Tap Detectors • Locksmithing • And More

7-Hour and 16-Hour Telephone Recorders Automatically Tapes Incoming/outgoing calls

FOR CATALOG SEND $5.00 TO: **SPY OUTLET**
P.O. Box 337, Buffalo, NY 14226 (716) 691-3476

AMAZING Electronic Products

ALL NEW

Portable Sensor Guard! - Detects intruders and sounds alarm. Works anywhere, from campsite to motel rooms!
SENSOR Ready to Use $29.50

Flashing Neon Wand High Visibility multicolored device. Use for emergency, night walking, warning beacon, decoration - many uses! NEON Ready to Use $29.50

3 Mile Voice & Telephone Tiny FM Transmitters
High performance, super sensitive, easy-to-assemble kits. XFM/XTL - 2 Units $49.50

Window Bounce Laser Listener
Aim at window and listen to sounds from reflected light. CAUTION: Not for illegal use. (req's video tripod) LWB30 Ready to Use $199.50

FREE CATALOG with Order or Send $1 P&H

INFORMATION UNLIMITED
Orders 800-221-1705

MC, Visa, Check, Cash, COD
Send or Fax Orders To: Dept PS2
PO Box 716, Amherst NH 03031
Fax 603-672-5406 Tel 603-673-4730

LASERS FROM $48.00 !!!
WE SELL LASERS FOR EXPERIMENTS, LIGHT-SHOWS, INDUSTRIAL APPLICATIONS. LEARN ABOUT LASERS WITH OUR PLANS, BOOKS AND KITS. START YOUR OWN LASER LIGHT-SHOW BUSINESS-PLANS ONLY $ 25.00!
CALL FOR YOUR FREE CATALOG !
MWK INDUSTRIES
1269W. POMONA,
CORONA,CA91720
(909) 278-0563
FAX: (909)278-4887

LASERS
He Ne Tubes and Laser Diodes from **$500**
FREE CATALOG
MEREDITH INSTRUMENTS
P. O. Box 1724
Glendale, AZ 85301

DO-IT-YOURSELF

Surveillance Devices !

MS - 25 Micro Speck *Telephone Transmitter Kit* Tiny - 1/3 the size of a dime! Professional quality - Crystal clear reception on any FM radio up to 1/4 mile. "SnapKit" technology for easy assembly!
$29.95
Also available: Tiny room transmitter highest power available. The most sensitive of any offered. **MD250 $44.95**

Guaranteed to be smaller than any other transmitters offered anywhere!

Telephone Transmitter Kit hidden in a dual modular adaptor Transmits both sides of conversation to any FM radio up to 1/4 mile. "SnapKit" Uses phone line for power & antenna! Goes completely unnoticed. **MA-100** $25.95

THR-12 12 Hour Telephone Recorder High quality cassette deck with telephone recording adapter built right in! Extends normal recording time up to 1 hours! Recording starts and stops automatically when phone is used! **Also available:** 2 line version **THR-24 $199!**
$99.95
free shipping Visa/MC (214) 255-7490
Seymor-Radix Inc. Box 166055 Irving, TX 75016

TELEPHONE LISTENING DEVICE

Size 1cu. in.

Record telephone conversations in your office or home. Connects between any cassette or tape recorder and your telephone line. Starts automatically when phone is answered. Records both sides of conversation. Stops recorder when phone is hung up.

$19.95 EACH Qty Disc Avail

Super Powerful FM TRANSMITTER
Many times more powerful than other transmitters. Transmits up to ¼ mile to any FM radio. Easy to Assemble Kit - up to 9V battery (not incl.) For catalog of Transmitters, Voice Scramblers and other specialty items, enclose $2.00 to USI Corp.
Call 407-725-1000 or send $19.95 + $1.00 shipping per item to: USI Corp., PO Box PS-2052, Melbourne, FL 32902 COD's OK.
1 x 1 ¾"

BUGGED? PHONE TAPPED? FREE Catalog of Counter-Surveillance Equipment tells you Fast! (800) 732-5000

CLASSIFIED! Ideas in designing the ultimate computer security system. Send $24.95 to: Information International P.O. Box 626, Hobbs, NM 88240

LONG RANGE LISTENING DEVICE. Hear sounds 1 mile away. Plans $3.00, Kit $35.00. D&F Concepts, 3646 E. Ray Rd., Dept 16-42, Phoenix, AZ 85044.

Make and Install Your Own **Auto Alarm** For A Fraction Of Dealer Price. For Beginner And Advanced Diagrams Send $5.95 To Security Planners 11191 Westheimer #248, Houston, TX 77042

Micro Video Camera Sees an entire room through 1/8" hole $215.00. 201-794-9766 Ext. 825

SURVEILLANCE-COUNTERSURVEILLANCE- WE HAVE EVERYTHING! Catalog $5.00 P.E.P. Box 930024-S, Norcross, GA 30093

TRADITIONAL HOMEMADE BRANDIES Kept Secret Behind Iron Curtain 50 Years- 7 Illustarated recipes And Instructed. Send $12 Global Connections, PO Box 265, Euless, TX 76039

ULTIMATE POTATO GUN. Shoots spuds upto 1500Ft! Plans $7.00 Adams, P.O.B. 681423, Schaumburg, IL 60168

UNBELIEVABLE SPECIAL! $8.95, 2 hour Home Wiring Videos, MC/VISA, Recording, 1-800-459-1109, GUARANTEED

UNUSUAL PUBLICATIONS! Strange stuff! Wierd plans! **FREE** catalog 185+ amazing publications! Electromart, Box 4-P, Carthage, TX 75633-0004.

EDUCATION & INSTRUCTION

HOW-TO ESTABLISH LIVING TRUST! Protect Inheritance. Avoid probate, lawyers! Comprehensive, smart kits, or software. Also: Wills, Lawsuit protection. Free Information. SOLARIS 1-800-233-9451.

EDUCATION & INSTRUCTION

Einstein was denied but one achievement:

A HIGH SCHOOL DIPLOMA

Luckily, you have an opportunity that Einstein never did. You can get a real High School Diploma at home in your spare time from ICS. Not a G.E.D., this diploma can be yours in as little as six months!

95P

DONT BE DENIED!

Call **1-800-595-5505** EXT. 7835

You Can Call 24 hours a day, 7 days a week!

Call now, or send this ad, along with your name and address, today for FREE information.

ICS LEARNING SYSTEMS
Dept. APC0655, 925 Oak Street
Scranton, Pennsylvania 18515

LEARN PC REPAIR- TROUBLESHOOTING, SERVICING. HOME STUDY. FREE LITERATURE. P.C.D.I., ATLANTA, GEORGIA. 800-362-7070 DEPT.JJH109.

PARALEGAL GRADED CURRICULUM. Approved Home Study. Affordable and Comprehensive. 100 years of legal training. Free catalog (800-826-9228) Blackstone School of Law, P.O. Box 871449, Department PS, Dallas, TX 75287.

PRESTIGIOUS UNIVERSITY DEGREES FROM RUSSIA: Intercontinental University, LTD. Off-Campus Degrees BA/BS MA/MS. PhD Without Classes. Reasonable Tuition. Write: C/O 220 W.19 Ste-2A. New York NY 10011

PRIVATE INVESTIGATION TRAINING! Big income! Own Boss! **FREE** Information. Probe, P.O. Box(PS) 2133, Beverly Hills, CA 90213-2133

UNIVERSITY DEGREES WITHOUT CLASSES. BACHELOR'S, MASTER'S, DOCTORATES. ACCREDITED, INEXPENSIVE, FAST. FREE INFORMATION. BEAR'S GUIDE, PO Box 7070, Berkeley, CA 94707. 800-835-8535.

ELECTRIC VEHICLES

VOLKSWAGEN CONVERSIONS. INFORMATION! 1-800-KAYLOR-K. PUBLICATIONS, VIDEOS, COMPONENTS. KAYLORKIT, POB 1550PS, BOULDER CREEK, CA 95006-1550

EMBLEMS, PATCHES, DECALS

CUSTOMIZED PATCHES, PINS, DECALS. FREE CATALOG, STADRI, 71R TINKER STREET, WOODSTOCK, NY 12498 (914)679-6600.

EMPLOYMENT INFORMATION

$329.84 Weekly Assembling Products At Home. Free Information. Toll Free 1-800-333-3294 (Message).

STOP! NEED A JOB? Assemble easy craft products from home! 1-800-377-6000 ex6055.

HELP WANTED

EARN MONEY Reading books! $30,000/yr Income potential. Details. 1(805) 962-8000 Ext Y-20025

Excellent Income! Assembling easy products at home. Program Guaranteed! 1-800-377-6000 ext.6050.

HOME TYPISTS, PC users needed. $45,000 income potential. Call 1-805-962-8000 Ext.B-20025.

HOME TYPISTS, PC users needed. $45,000 income potential. Call 1-805-962-8000 Ext.B-20025.

ENERGY SAVING

SAVE ENERGY. EXTEND LIFE OF HEAT-PUMP & CENTRAL AIR UNITS. Simple, inexpensive. Information, plans. $4.95 postpaid. Brindleline Concepts, 2605 Conley Rd., Morganton, NC 28655.

SOLAR, GREENHOUSE, AQUACULTURE, ENERGY SAVINGS CATALOG! 50 pages. Featuring Sun-Lite(tm). Solar/electric vehicles, **conversion kits and components.** $2.00 postpaid. Solar Components, Dept. PS, 121 Valley St., Manchester, NH 03103.

FINANCIAL

Clean Up Your Credit! Guaranteed. 50 Page Repair Kit. **Free Credit Report.** Send $7.00 Onyx House 490 Wall Street. Eatontown, NJ 07724

FEDERAL LOANS for small business now available. 1-800-777-6342 for free detail.

MONEY TROUBLES? REDUCE INTEREST CUT CREDIT CARD PAYMENTS. SAVE THOUSANDS. CALL 1-800-SAVE-ME-2.

National Bank Seeking Distributors To Market No Fee Secured Mastercard. Phone 305-254-6862

OVERDUE BILLS? 1-800-869-0607. Bad credit's no problem! Licensed / Bonded. Applications to $50,000. Not loan company. TCAC. Box 26397, Birmingham, AL. 35260.

Quick CASH. No Collaterial. No credit check. No up-front fees. 213-882-4269

SMALL BUSINESS - Let the Government Finance You! Loans, Grants, Assistance! Satisfaction Guaranteed! 1-800-226-3601, BF6050.

FOR INVENTORS

WORK DIRECTLY WITH
REGISTERED PATENT ATTORNEY & GRADUATE ENGINEER
36 YRS ENGINEERING & PATENT EXPERIENCE
U.S. & FOREIGN PATENTS
PATENT AND DEVELOP IDEAS WITH THE EXPERIENCE OF AN EXPERT. FREE 228 PAGE BROCHURE. CONFIDENTIAL ADVICE AND FORMS.
INTRODUCTION TO INDUSTRY, MARKETING PLANS, OFFSHORE PRODUCTION & PROTOTYPES
Also Specializing in Copyrights & Trademarks
Associates located at Patent Office
CREDIT CARDS ACCEPTED • SAT/SUN HOURS
MICHAEL I. KROLL
REGISTERED PATENT ATTORNEY
US PATENT REGISTRATION #26,755
171 STILLWELL LA., SYOSSET, NY 11791
TOLL FREE US/CANADA 800-367-7774
Toll Free FAX - US & Canada 800-367-7773

WHY "RISK IDEAS" TO STRANGERS

Now conduct Your own US/Patentability-search, simply follow my 20 yr. top-expertise as US/Patent-Researcher. My EZ-form secures a valid US/Pat. Office *"Official Registration Serial-number & vital Priority-date of Conception!"* My Comprehensive EZ-Guidebook: *"How to Conduct A US Patent-Search Yourself & Save!"* Maintains Invention Secrecy! ***Order Now, Receive Both!! Only → $19.95***
INVENTECH® 3350-A KURTZ, SAN DIEGO CA 92110

INVENTOR'S HELPER
Have a Bright Idea?
PROTECTED Ideas Have **PROFIT** Potential!
PATENT SEARCH $95 / 2 DAYS
PATENTS * TRADEMARKS * COPYRIGHTS
FREE BROCHURE
(800) 633-9729 (516) 757-2573

$25 Patent Search? There's a catch, but a nice catch! Details! $1, SASE. JJANA, 402 First, Franklin, MN 55333.

AFFORDABLE PATENT APPLICATION PREPARATION, FREE QUOTE, VISA/MC 1-800-357-IDEA. JOSEPH N. BREAUX, REGISTERED PATENT ATTORNEY.

Copyrighted material

FOR INVENTORS

Canadian Industrial Innovation Centre's **Workshop for Inventors:** Edmonton Oct. 28th, Toronto Nov. 25th, **Toys & Games Workshop** Sept. 23rd Call: 1-800-265-4559, Fax 519-885-5729

DON'T BE FOOLED! CALL OUR INVENTORS CLUB 24 HOURS FOR INFORMATION. 1-800-466-1793

FREE help for inventors! No charge for protection forms and information kit. Affiliated Inventors Foundation. 1-800-525-5885

FREE INVENTION PACKAGE: Davison & Associates offers customized Development, Patenting, and Licensing. Proven Results: 1-800-677-6382

FREE PROTECTION CERTIFICATES, PATENT DEVELOPMENT, MARKETING, INFORMATION. U.S. Patent Office Examiner Suite 702PSF 233 Broadway, New York, NY 10279

Invention enhancement method guarantees strongest, most economical, patent protection. Michael Fitzpatrick 516-564-4752

INVENTORS! Can you patent and profit from your idea? Call **AMERICAN INVENTORS CORP.** for free information. Serving Inventors since 1975. 1-800-338-5656.

INVENTORS' DIGEST. Celebrating ten years as America's only inventors magazine. $22 per year. 1-800-838-8808.

INVENTORS!! DO YOUR OWN PATENT SEARCH. HOW-TO Booklet $12.95 COLORPRINT PUBLISHING, 610 Court St., Clearwater, FL 34616.

INVENTORS: Experienced patent attorney in Washington, DC. Free information package 800-876-6670, J.P. Halvonik

INVENTORS GUIDE! A complete guide to developing, patenting, and marketing your invention. By an inventor for inventors. $14.95 1-410-535-6594

INVENTORS -- NEVER SEND IDEAS TO STRANGERS! AVOID SCAMS - SAVE THOUSANDS! REVOLUTIONARY, PROTECTION/MARKETING METHOD! NONPROFIT ORGANIZATION. FREE INFORMATION: 1-800-846-3228.

INVENT SOMETHING? ESI Inc. links unconnected individuals with decision-makers. Free brochure supplied. (800) 547-7885

NATIONAL REGISTRY. Protect ideas before showing anywhere. Questions? Box 945 Narberth, PA 19072

PATENT AND DEVELOP Your Invention. Registered Patent Agent and Licensed Professional Engineer. Send for **FREE PATENT INFORMATION** Every Inventor Should Have. Richard L. Miller, 12 Parkside Drive, Suite-N, Dix Hills, NY 11746-4879. (516)499-4343.

PATENT IT ECONOMICALLY! Free details. Licensed since 1958. Rainer Associates. 2008 Fondulac, Richmond, VA 23229

"PAY ON SALES MADE" We'll Launch Your National T.V. & Print Campaign Free. Application & Eligibility Study Required. Restrictions Apply. AS SEEN ON T.V. INC. 407-626-0688.

REGISTERED PATENT ATTORNEY. D.A. Kettlestrings. Free patent/trademark information. 1-800-966-7577.

SCAM INVENTION MARKETING COMPANIES EXPOSED! Free report. Talk with actual victims in your state. 800-428-5779

S.E.L.L. YOUR IDEA..... Free info. on Patents, Licensing, Marketing, based on 25 yrs Exp. Harshaw Research 800-451-1326

STOP PAYING FOR UNMARKETABLE DESIGN PATENTS! PATENTials INCORPORATED: SEARCHES, PROCURES UTILITY PATENTS, MARKETS & LICENSES INVENTIONS FOR A PERCENTAGE. 800-261-7467

GOOD EATING

SAUSAGE- MAKING, Smoking, Free catalog of equipment, ingredients. Semplex, Box 11476H, Minneapolis, MN 55411. 1-800-488-5444

GOVERNMENT SUPLUS

CASH -IN ON MILITARY BASE CLOSINGS. Complete guide on Selling and Buying Surplus for PROFIT. The author, a former Navy Supply Officer- now president of Surplus & Supply International Corp., provides comprehensive details. 1-800-557-0924

GOVERNMENT AUCTIONS in your area. Cars, Trucks, Computers, more! Satisfaction Guaranteed! Call now: 1-800-601-2212 Ex.SP6050.

HAIR CARE

MEN'S 24 PAGE HAIRPIECE CATALOG! For $20.00 Discount Mention This Ad. Call: 1-800-448-0133. Fax: 1-203-375-9270

HEARING AIDS

FREE CATALOG!

New Hearing Aids

- All Models
- Huge Savings
- No Salesman will call

Try Before You Buy!

Write: Rhodes Hearing
20112 Ohio St., Brookport, IL 62910
1-800-453-4905 (24 hrs.)

Hearing Aids Deal Direct. Guaranteed Lowest Discount Prices. Top Quality Made in the USA. Home Trial Free Information. 1-800-641-4327. True Sound

HEARING AIDS- GUARANTEED LOWEST PRICES! No huge commissions. Home trial, terms. All makes. We're the oldest, biggest, best. Custom instrument specialists. Free information,(800) 323-1212. Lloyds - PSC.

TOP QUALITY- BEST PRICES- FREE CATALOG. Home Trial, Call SCI Hearing 1-800-414-1551

HYPNOTISM

FREE! Self Hypnosis Report. Write: **JKL** 384 Penobscot Building, Detroit, MI 48226-P

INVENTIONS

INVENTIONS, ideas, new products! Presentation to industry/ national exposition. 1-800-288-IDEA.

INVENTIONS WANTED

INVENTIONS DEVELOPED MARKETED Free **PROTECTION CERTIFICATES.** Patent Office Former Examiner, Licensed Patent Engineer, Manufacturers Representative. Patmart, Suite 702PS, 233 Broadway, New York, NY 10279

INVENTORS: The Concept Network represents inventors who want to PATENT and MARKET their new product ideas. Call 1-800-835-2246 Ext 144 for free information kit.

INVENTORS: Utilize The Logical Process to **Protection** and Potential **Profits. Free Advice.** APSI Washington DC 800-458-0352

KITES

FREE KITE CATALOG! 1-800-724-7267 Ext.PS 100's of Kites! Fantastic Selection! **Call (24Hrs) 1-800-724-7267 Ext.PS**

LOANS BY MAIL

SIGNATURE Loans, must have checking account & steady job. Call 1-800-445-0680.

LOCKSMITHING

LOCKSMITH MANUALS, TOOLS, CATALOG $10.00, SCHOOLING BROCHURE $2.00. ABCS, PO BOX 727 SHERBORN, MA 01770.

LOTTERY

Innovative Jackpot System Increase Chances 1/Ten. Information: Winner Box 102 Suwanee, GA 30174-0102

MISCELLANEOUS

FREE LIST SECRETS PRODUCTS PLANS SASE to Clarity, Box 604908, Flushing, NY 11360-4908.

NOVELTIES

SKELETON KEY

Amaze Your Friends

You Get 3 Sized Tension Keys. Precise Instructions & More. Note: this device is to be used for demonstration purposes only! Satisfaction Guaranteed or Full Refund. 2 weeks delivery. Send NOW only $8.95 + $2 S&H to: **Safe Marketing Co., 90 W. Montgomery Av No.366R, Rockville Md 20850**

FINALLY...ENDLESS SUPPLY OF PERFECT SKIPPING STONES. REUSABLE MOLDS + INSTRUCTIONS 40 CAVITY MOLD $9.95, 100/$16.95 : DESIGN FOCUS, BOX 285, ANDOVER, N.J. 07821-0285. 908-852-1264.

OF INTEREST TO ALL

FREE INFORMATION! Avoid probate. Save attorney's fees. protect your family. Write: Book Gallery, 13681 Newport Ave- #8-179S, Tustin, CA 92680

SAVE LIVES, SECURE YOUR GUNS! PLANS $7.50, BOX 636. PETALUMA, CA 64953.

PLANS & KITS

Dome Homes - Pre-cut kits - Superinsulated - Dome Tour Video - Natural Spaces 1-800-733-7107.

PLANS, BLUEPRINTS

Build An Heirloom Of American History All Wood Gear Clock Early 1800's Plans $15.00 Haney Klox Box 1821 Lakeport, CA 95453

BUILD "FREE" ENERGY MOTOR. Photos, Plans & Parts List. All Magnetic, No batteries, $5.00 To Howard Menger 845 28th Ave Vero Beach, FL 32960

MINI OVERHEAD CONVERTER. Good For Runs Of Small Parts. Send $5.00 For Plans To John Klendshoj P.O. Box 99 Clarence, N.Y. 14031

Revolutionary desk design build at home plans $10. Parrotdisc Inc. PO Box 681, Troy, NY 12180.

PLASTICS

CASTOLITE Liquid Plastics. Crystal clear, colors. For casting, embedding, coating, fiberglassing, repairing and reproducing with our Mold Making Supplies. Catalog $3.00. CASTOLITE, Dept. 95G/PS, 4915 Dean, Woodstock, IL 60098.

RUBBER, plastic compounds, techniques, sources. Free information: Caster, Box 16586V7, Memphis, TN 38186-0586.

SONGS COMPOSED FROM YOUR POEMS. Recording- Publishing- Cash Awards. Broadway Music Productions. Box 7438PS, Sarasota, FL 34278.

REAL ESTATE

MONTANA

Trees, Creeks and Wildlife, 20 QUALITY acres (and up), close to Yellowstone Park, starting at $19,500 or less. Easy Owner Financing. Guaranteed Access. Warranty Deed. Free Color Brochure.

Rocky Mountain Timberlands
1315 East Main • Dept. PS, P.O. Box 1153
Bozeman, MT 59771-1153 • (406) 586-8088

Call Toll Free: 1-800-682-8088

GOVERNMENT LAND
US CITIZENS ONLY

20 acre claim program still available, get yours for $20 government fee, in AK, AZ, AR, CA, CO, ID, MT, NV, NM, OR, UT, WA, WY. For complete, step-by-step package including maps, telephone helpline, filing forms, etc. send $20; or for more information send $3. PUBLIC LANDS TITLE, PO Box 2945-PS Port Angeles, WA 98362-0336 (this is not Homesteading, it's much easier and only costs $1. per acre).

BARGAIN HOMES- Foreclosed, HUD, VA, S& Bailout properties. Low Down. Fantastic savings. Call 1-805-962-8000 Ext. H-20025 for list.

CALIFORNIA. Acreage. Lots $50 down. $5 monthly. 4602 Ethel Ave., Sherman Oaks, C 91423

COLORADO LAND. Free list of spectacula land from 40 to 20,000 acres. Ponderosa pines canyons, 360 degree views, creeks, Nationa forest. Owner financing. From $250 per acre Call Red Creek Ranch, 719-485-0656 Voi Where Prohibited

GOVERNMENT LAND now available for claim Up to 160 acres/person. Free recorded message. (707) 448-1887. (4JG6)

REMAILING SERVICES

CONFIDENTIAL ADDRESS. FORWARDING WORLDWIDE. VOICEMAIL. MAILPOST 2421PS Pratt, Chicago, Illinois 60645 312-764-0100, 800-890-3199

ROOFING

STOPPING ROOF PROBLEMS

on flat, sloped and geo-dome roofs since 1978. Liquid applied Fiberglass Reinforced Acrylic Roofing System. It Waterproofs. Apply on metal, waferboard, asphalt, styrofoam, plywood & other new roof sheathing materials. For commercial, industrial & residential roofs. Stops leaks & roof rumble in mobile homes. Weatherproofs solar panels, sky lights, fiberglass roof panels. Stops rust on metal and structural steel, bridges, etc.

POLAR SEAL ROOF SYSTEMS

We still have areas available in various regions for Dealers and Distributors Inquiries are welcome.

Call **POLAR SEAL**
1-800-343-7663
MON-FRI 8AM - 5PM
FAX 1-219-356-1859
HUNTINGTON, IN.

SATELLITE TV

Satellite-TV **FREE** 64 Page Catalog/Buyer's Guide

100% Satisfaction Guarantee

- All Major Brands
- Complete Systems
- Accessories.
- Huge Savings
- Easy Installation
- Complete Intruct.

Over 1 Million Depend on *Skyvision*

1-800-334-6455
Int'l 218-739-5231 Fax 218-739-4879
Skyvision, Inc.®
1030 FRONTIER DRIVE
FERGUS FALLS, MN 56537

INSTALL OR UPDATE YOURSELF!

Get sound for **VIDEOCYPHERII** like others do without codes. $19.95. NASSIRIAN, Box 382-S Rio Linda, CA 95673

LOWEST PRICES FOR SERIOUS BUYERS Shop around, call us last. Free price list. 4 years in business. ANTENNA KING 1-800-814-5377.

Copyrighted material

SATELLITE TV

AVE MONEY MAKE MONEY. Repair Satellite shes Video Tape& Catalog. $19.95+ $4.95 ipping C-Satellite. P.O. Box 926 Belchertow-MA 01007 1-800-618-6742

SCIENCE & CHEMISTRY

EMICALS. WE CARRY ANYTHING YOU EED IN LABORATORY CHEMICALS, ASSWARE, INSTRUMENTS AND SUP-IES. ADVANCE SCIENTIFIC. 305-327-0900

OLD LIGHT KITS- Chemical, Sound, Elec-cal, Bioluminescence. SASE for information: RYOLUME, 2139 North University Drive, #274 oral Springs, FL 33071

XPERIMENTERS" LABORATORY EMICALS GLASSWARE, Catalogue $2.00, tablished 1953. Hagenow Laboratories, 1302 ashington, Manitowoc, WI 54220.

VERTED- GRAVITY CHAMBERS COM-LETE PLANS & THEORY $18.00 SDK P.O. x 25942 Los Angeles, CA 90025

aboratory" Glassware, Chemicals.Catalog .00. Southern Oregon Scientific, 1000 SE M reet. Unit A, Grants Pass, OR 97526

boratory Supplies: Testing, Research. talog: $1.00. Chemicals, Glassware. Chem-tech, P.O. Box 24606, Columbus, OH 43224. 14)263-3588.

SCIENCE & CHEMISTRY

MAILORDER NATIONWIDE- CHEMICALS AND LABORATORY SUPPLIES- GLASSWARE. OVER THE COUNTER SALES IN CALIFORNIA. SAME DAY SHIPPING. WHOLESALE SCIENTIFIC CO., INC. 415-637-8888.

MAKE YOUR OWN ROCKETS homemade fuels, chemicals, plans, supplies catalog $3.00. PYROTEK, P.O. Box 1, CATASAUQUA, PA 18032 717-256-3087

SOLAR ENERGY/HEATING

Solar Pool Heater 1000SF $100 Plans $10+ SASE. Solar POB 265432 Daytona Beach, FL 32126-5432

STAMP COLLECTING

DISCOUNT, STAMPS, PACKETS, FREE LIST IVA, BOX 197-B, HANFORD, CA 93232

DISCOUNT, STAMPS, PACKETS, FREE LIST IVA, BOX 197-B, HANFORD, CA 93232

Penny Stamp Approvals, Regardless Catalog. Kloster 18289 Bunny Drive, Jamul, CA 91935.

TOOLS & MACHINERY

Compact 5

LATHES
•Starting at $ 410
•Mills •Metals •Books
•Precision Instruments
Catalog $ 1.00

513- 322-8562 (800 number for orders)
CAMPBELL TOOLS COMPANY
2100-P SELMA RD. SPRINGFIELD, OH 45505

MACHINIST'S!! UP-DATE YOUR SHOP!!

BLUE RIDGE MACHINERY AND TOOLS, INC.

MACHINERY, TOOLS, METALS, SUPPLIES, BOOKS, VIDEOS, MUCH MORE

FREE CATALOG • CALL (304) 562-3538
BOX 536-PS • HURRICANE, WV • 25526

CNC MACHINES From $3,495

• Mills • CAD-CAM
• Lathes • PC-Controlled
• Routers • State-of-the-Art

Metal, Woodworking, Plastics, Jewelry, etc.

BOBCAD CONTROLS, INC.
Call for FREE info: (310) 606-9340 or (800) 501-2886

TOOLS & MACHINERY

4" Metal Cutting Lathe $129.15. Taig, 12419 Nightingale Lane, Chandler, AZ 85249.

BOLTS, SCREWS, TOOLS, WHOLESALE, DIRECT. Guaranteed. Catalog $2.00 (refundable). Camelot, Dept. 33, Box 65, Bristol, WI 53104.

WANTED TO BUY

Gold, Silver, Platinum (any form). Assaying service. Free price quotes. Top payment. 1-800-932-1010/ 617-326-3442

WATER PURIFICATION

Electronic Water Softener no chemicals or plumbing needed, removes limescale from pipes, perfect for septics, moneyback guarantee, $399.95 call **EcoSoft** 1-800-275-7070

SOLID STATE WATER CONDITIONER. Magnetically alters limescale to prevent formation in pipes, tub, tile, and fixtures. Increases water flow. No chemicals, electricity, or plumbing required. Lifetime Warranty. $149.95 Jenesco Inc. 800-639-9471

Waterwise Purifiers... homemade distilled. (800) 874-9028. Box 45981, Center Hill, FL 33514-0459

Classified Advertising

POPULAR SCIENCE CLASSIFIED ADVERTISING MART

Order Form

$13.65 PER WORD
12 word minimum

BOLD FACE CAPS add $1.00 a word

WORD COUNT: Each word or initial in mane and address must be counted as a word: John E. Jones, 345 East Main St., counts as SEVEN words. P.O. Box 3 counts as THREE words. City, standard 2-letter state abbreviation and zip code together count as TWO words.

DEADLINE FOR ADS: October 1995 issue (on sale September 12th) closes July 13, 1995

TERMS: Payment with order or charge your VISA, MasterCard, American Express or Discover account.

To: Classified Advertising Dept. POPULAR SCIENCE, 2 Park Ave., New York, NY 10016

☐ **Remittance of $_____ is enclosed to cover _____ insertion(s) in the _____ issue(s).**

☐ **CHARGE to: _____ Exp. Date _____**

Heading my ad should be under: _____

1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18
19	20	21	22	23	24

YOUR NAME _____ PHONE _____
(PLEASE PRINT)

FIRM _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

DATE _____ YOUR SIGNATURE _____

PS 7/95

(PLEASE PRINT OR TYPE COPY • FOR ADDITIONAL WORDS ATTACH SEPARATE SHEET)

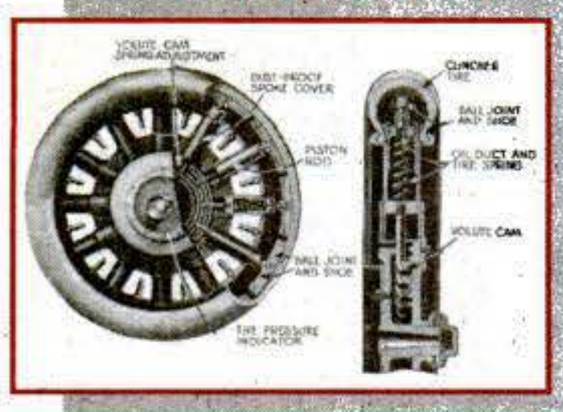
Popular Science

LOOKING BACK

EDITED BY WENDI E. BLACK

75 YEARS AGO

AIRLESS TIRE



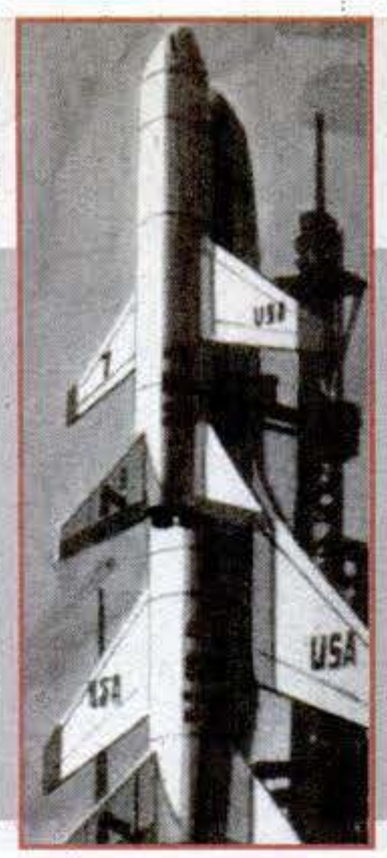
Tire punctures are a thing of the past with a new combined tire and wheel. The non-pneumatic tire consists of rigid tubular spokes that extend from the wheel hub to the rim, which is made to fit a clincher tire casing. The spokes hold the casing under spring pressure, which will support and cushion the vehicle as effectively as an air-filled inner tube."—*July 1920*

So-called run-flat tires are the latest in tire technology. Stiffened sidewalls reinforced with extra layers of rubber enable the tires to continue to run when they are punctured or simply low on air. Cars equipped with run-flat tires alert the driver to low air pressure via a gauge on the dash.

25 YEARS AGO

SHUTTLE BUS

Toward the end of the 1970s, you will no longer have to go through years of astronaut training if you want to go into orbit. The space shuttle will be manned by astronauts in the cockpit and function like a commercial liner in the cabin. Following careful checkouts, refurbishing, and refueling, this shuttle can be used over and over again."—*July 1970*



25 YEARS AGO

SAFER SKIES

All planes may have access to inexpensive and compact aircraft collision-avoidance systems by 1973. RCA Defense and Commercial Systems has completed preliminary designs of SECANT (Separation Control of Aircraft by Nonsynchronous Techniques). Planes that use this system exchange radio signals that warn of the threat of impending collision. Able to function independently or in conjunction with ground-based air traffic control, the system even instructs the pilot of the best evasive maneuver."—*July 1970*

Passenger aircraft are now required to have Traffic Alert and Collision Avoidance Systems. TCASs scan the air every second for transponder signals emitted by other jets. These signals are displayed on a monitor in the cockpit to warn pilots of impending traffic; computer-generated voice commands also warn pilots to dive or climb.

100 YEARS AGO

EARTHQUAKE ACTIVITY

An investigation of the movement of earthquakes reveals that, beyond a radius of a few hundred miles, their disturbances are often too feeble to be recorded by the ordinary seismograph. Their presence is made known by use of specially constructed pendulums. An earthquake, from its epicenter in Tokyo, was recorded traveling to Italy in fifteen to twenty minutes."—*July 1895*

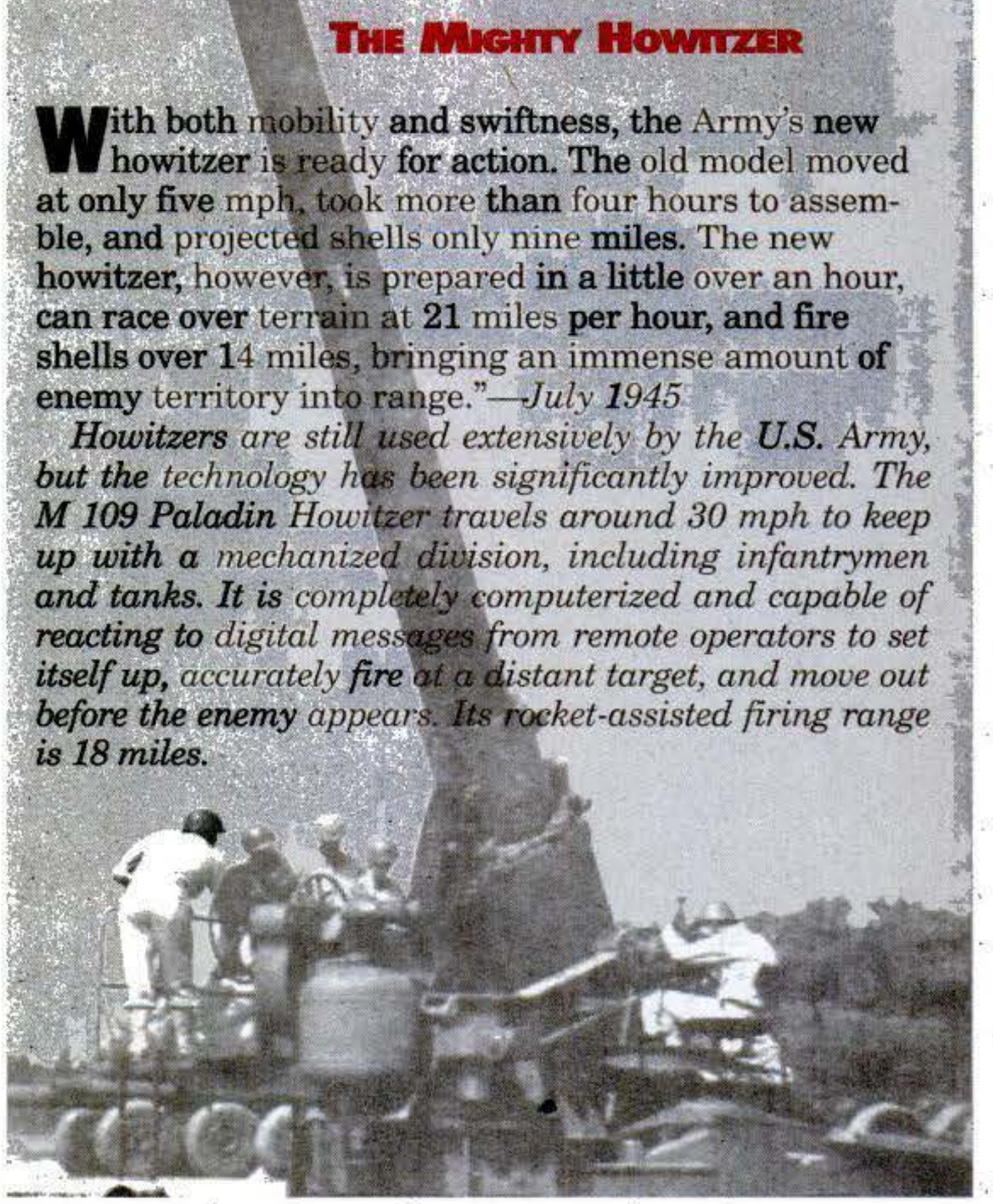
Today, earthquake movements are still measured by seismographs. These modern instruments, however, log even the most minute displacements of the earth. Seismographs use a wire coil in a magnetic field. When movement in this field occurs, currents are generated across the coil and measured.

50 YEARS AGO

THE MIGHTY HOWITZER

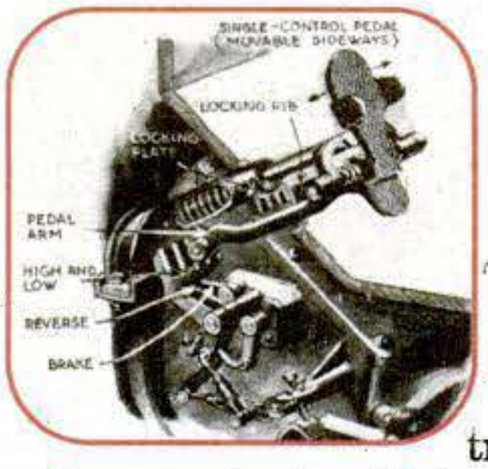
With both mobility and swiftness, the Army's new howitzer is ready for action. The old model moved at only five mph, took more than four hours to assemble, and projected shells only nine miles. The new howitzer, however, is prepared in a little over an hour, can race over terrain at 21 miles per hour, and fire shells over 14 miles, bringing an immense amount of enemy territory into range."—*July 1945*

Howitzers are still used extensively by the U.S. Army, but the technology has been significantly improved. The M 109 Paladin Howitzer travels around 30 mph to keep up with a mechanized division, including infantrymen and tanks. It is completely computerized and capable of reacting to digital messages from remote operators to set itself up, accurately fire at a distant target, and move out before the enemy appears. Its rocket-assisted firing range is 18 miles.



75 YEARS AGO

EARLY GEARSHIFT



Changing speeds with one foot has been made possible by an inventor from Brooklyn, New York. A single pedal is used to control all speeds, including the reverse and service brakes. Drivers no longer need to hold the low and high pedal in neutral while using the other foot to brake or move in reverse."—*July 1920*

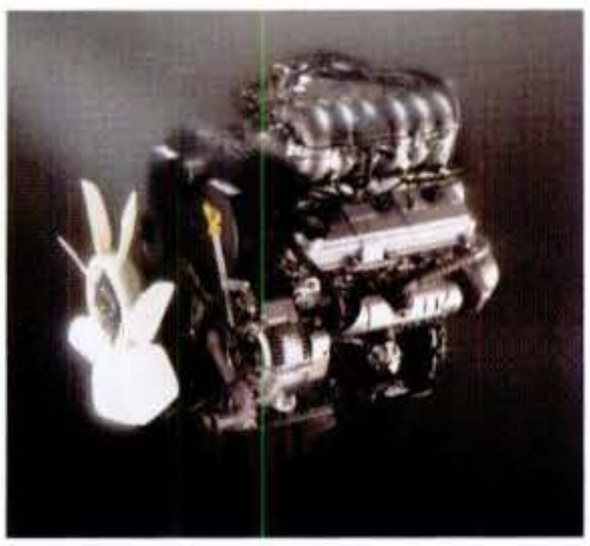
POPULAR SCIENCE **Business and Executive Offices:** 2 Park Ave., New York NY 10016. **Editorial Offices:** Address contributions to Popular Science, Editorial Dept., 2 Park Ave., New York NY 10016. We are not responsible for loss of unsolicited materials. They will not be returned unless accompanied by return postage. Microfilm editions are available from Xerox University Microfilms Serial Bid Coordinator, 300 N. Zeeb Rd., Ann Arbor MI 48106. **Subscription Inquiries:** Send new or renewal subscriptions or change of address (send both new and old addresses) to Popular Science, Box 5096, Harlan IA 51593-2596. Allow six to eight weeks for change of address. If you have a subscription problem, please write to the above address. **Subscriptions:** U.S. and its possessions, 1 year $13.94; 2 years $24.97; 3 years $34.97. For Canada, add $7 per year (includes GST). For Foreign, add $8 per year. Subscriptions processed electronically. **Postmaster:** Send change of address notices to Popular Science, Box 5096, Harlan IA 51593-2596. Popular Science entered as second-class postage paid at New York NY and additional mailing offices. Canada Post Canadian Publications Mail Product Agreement No. 56219. Canada GST Registration Number R-122988066. Popular Science (ISSN 0161-7370) is published monthly by Times Mirror Magazines, Inc., 2 Park Ave., New York NY 10016.

PRINTED IN THE U.S.A.

Copyrighted material

Introducing the TOYOTA T100 XTRACAB.

It's THE Toyota of BIG trucks.

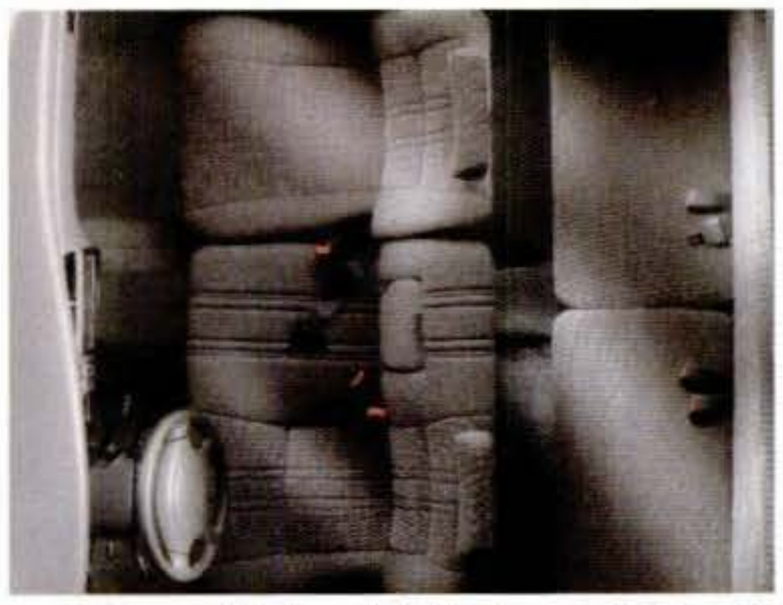


*The new multi-valve engine out-performs V8s** and delivers 2,150 lbs. payload capacity;*** 5,200 lbs. towing capacity† and valuable fuel economy.**

It's having both spacious ROOM for six and AGILE handling. It's having both a new 190-HORSEPOWER engine and sensible fuel ECONOMY.* It's the rugged CAPABILITY of a welded steel cab and full-box frame combined with DETAILED refinements like a superbly CRAFTED interior and sophisticated SAFETY systems.

It's an ALL-NEW truck that comes with Toyota's legendary REPUTATION. The all-new Toyota T100 Xtracab.

It's ENGINEERING that goes beyond.



Craftsmanship abounds in the spacious interior with room for six people, standard driver air bag" ***and 3-point seatbelts at all outboard positions.***

Call 1-800-GO-TOYOTA for a BROCHURE and the location of your NEAREST DEALER.

TOYOTA T100

I Love What You Do For Me

©1994 Toyota Motor Sales, U.S.A., Inc. Buckle Up! Do it for those who love you. *17/20 city/highway EPA estimated mpg for 4x2 Xtracab DX with 5-speed manual transmission. See your Toyota dealer for details. **Performance based on USAC-certified acceleration tests, w/ and w/o 500-lb. payload. T100 Xtracab SR5 versus similarly equipped full-size extended cab standard V8 Chevrolet, Dodge and Ford trucks. ***Including occupants, equipment and cargo on 4x2 Xtracab DX with 5-speed manual overdrive transmission. †4x2 V6 models not to exceed GCWR of 9,200 lbs. Requires Class IV-rated towing hitch receiver. "To help avoid serious injury, always wear your seatbelt. Driver air bag is a supplemental restraint only.

Copyrighted material

Presenting Gillette SensorExcel

With soft, flexible microfins for the closest shave ever.

Gillette offers you SensorExcel,™ the next revolution in shaving closeness.

We started with Sensor's spring-mounted twin blades that adjust to your face.

Then we developed a remarkable innovation called microfins and placed them ahead of the blades. These soft flexible fins gently stretch your skin, causing your beard to spring upward so the blades

can shave you closer, with more comfort.

SensorExcel's responsive Flexgrip™ handle and unique pivoting action give you superior maneuverability and control.

The result is the closest, most comfortable shave you've ever experienced. Get Gillette SensorExcel. And get closer than ever before.

Gillette

The Best a Man Can Get™

© 1995 THE GILLETTE COMPANY (USA)